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Managing the environment in a changing climate

A report to Defra and the Welsh Assembly Government
in response to a direction to report under the Climate
Change Act 2008

November 2010

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Executive summary

The climate is changing and will continue to do so even if greenhouse gas emissions reduce. Understanding of the nature, timing and scale of these changes is imperfect but we know enough to assess the likely implications for what we do. This report sets out the Environment Agency's climate change risks and our plans to address them. It has been written in response to a direction to report from the UK and Welsh Assembly Governments under the Climate Change Act 2008.

The Environment Agency's core business involves protecting and improving the environment of England and Wales for people and wildlife and contributing to sustainable development. It is important that we understand and respond to the factors that impact on these outcomes. Weather conditions are already a central consideration for us. Heavy rain, for example, washes chemicals and nutrients off farmland into rivers in addition to contributing to flooding by swelling streams and rivers. Temperature changes can have significant impacts on wildlife and people. A changing climate therefore represents a major challenge to the environment and our work. We take this challenge seriously and have been responding to it for a number of years.

As we write this report, the first UK climate change risk assessment is being prepared. Government Departments are implementing their own adaptation plans and a number of organisations are preparing reports like this one. Others will be starting to consider what they need to do differently as the climate changes. We hope that our approach is useful to others. It involves assessing the risks that climate change poses for each of our strategic objectives, focusing on the importance of the impacts, when they might occur, when we need to start taking action, how much effort we need to put in to adapt and then prioritising them. We have set out the actions we will take, building on our existing plans.

Our priorities are to address the risks that climate change poses to our work on flooding, coastal erosion, water resources, water quality, wildlife and habitats. We have used the outputs of the UK Climate Impacts Programme (UKCIP) to understand climate change hazards. We have used our own evidence in combination with UKCIP output to understand the impacts on the issues that are most important to our responsibilities. We are most concerned about the impacts arising from changes to rainfall, sea-levels and temperature.

The work of UKCIP indicates that rainfall patterns will change with more rain during the winter and more of it falling in short and heavy bursts. There may be less total rain in the summer but with heavy downpours. Our modelling shows that this will translate into large decreases in river levels in the summer and autumn months coupled with higher flows in the winter. We expect inland flood risk to increase as a result in both urban areas and in the countryside, but the effects will vary across England and Wales. Droughts may also become more common.

All these changes will influence water quality and will add to the pressures that habitat loss and invasive non-native species are already having on wildlife which will be further affected by rising temperatures. Rising sea-levels will increase the frequency and height of extreme high tides and increase the likelihood of coastal

flooding, especially on the east and south-east coasts of England. Sea-level rise will also lead to greater wave attack on coastal cliffs whose stability will be further affected by changes to rainfall.

In addition to our top priority risks our assessment has identified a number of other risks that we need to manage. These are described in the report and include risks to the buildings and equipment that we use and the systems and processes that allow us to operate.

The actions we plan to take fall into a number of categories, reflecting our regulatory, operational and advisory roles and include:

- Working with a wide range of partners to ensure that a sound evidence base underpins our own decisions and the advice we give to others. This will involve both research and analysis, including using the latest set of UK climate projections to characterise changes to river flows and to help us improve our knowledge of coastal processes;
- Providing advice, guidance and data to others to help them play their part in adapting to climate change. We have developed guidance for organisations directed or invited to report under the Climate Change Act, which focuses on flooding, coastal change and water resources. It is available on our website.
- Ensuring that climate change is considered in everything we do. We are ensuring that the further development of River Basin Management Plans under the Water Framework Directive takes account of climate change. Because of the inherent uncertainties in this work we take a flexible approach wherever we can so that we can adjust as we go. For example, our approach to the management of flood risk incorporates the flexibility to adapt to future changes in a timely way but not prematurely.

We are already taking action to adapt to climate change. Going forward we will prioritise our efforts to address our priority risks. We will monitor the changes to these risks over time and modify our action plans as appropriate. We will continue to develop our evidence base with others; identify and share good practice approaches to managing climate risks; and ensure that our staff and partners have the knowledge, skills and tools they need to act.

1 Introduction

The Climate Change Act

The Climate Change Act 2008 gives Government the power to direct certain public bodies to report on their climate risks and adaptation plans.

We received a joint direction to report from the Secretary of State for Environment, Food and Rural Affairs and the Welsh Ministers in March 2010.

Our direction asks us to provide:

- a summary of our statutory and other duties;
- the method used to assess current and projected climate impacts on these;
- a statement of the policies and proposals we will pursue in response;
- our plans and timescales to implement these proposals.

This report sets out the risks and our adaptation plans for England and Wales. We have made it clear where risks or plans differ between the two countries, for example due to devolved policy.

Who we are and what we do

The Environment Agency of England and Wales (The Environment Agency) is established under the Environment Act 1995 to protect or enhance the environment and to contribute to sustainable development.

We are responsible to the Secretary of State for Environment, Food and Rural Affairs (Defra) and are an Assembly Government Sponsored Body responsible to Welsh Ministers. We have staff based across England and Wales and work actively with local communities. We have regulatory, operational and advisory roles in:

- flood and coastal risk management
- water quality and resources
- conservation and ecology
- regulation of major industry
- waste management
- agriculture
- navigation
- fisheries
- contaminated land
- climate change and energy

We have specific statutory and non-statutory responsibilities in all of these areas.

Climate change is a priority for us

The climate is changing and will continue to do so – even if greenhouse gas emissions reduce. We know that the environment is fundamentally affected by climate and that even relatively small changes in rainfall or temperature can have large impacts on people and wildlife. Climate change is therefore central to our work and we recognise that adaptation is essential for a healthy and safe environment. We also know we need to work with communities and partners in industry and government in this area.

We published our first adaptation plan in 2005 and updated it in 2008. We have been taking actions for a number of years to both improve our understanding of the effects that climate change will have on our work and to address climate risks. Annex 2 lists actions that we have already taken.

The Environment Agency Board has endorsed the following commitment to managing climate change:

- We will help England and Wales meet greenhouse gas emissions targets in ways that minimise other environmental impacts.
- We will help people and wildlife adapt to climate change and reduce its adverse impacts.
- We will put climate change at the heart of everything that we do.

Our approach

To assess risks and develop adaptation plans, we have:

- systematically identified the activities undertaken by all our business functions;
- identified those activities which are sensitive to climate change;
- reviewed our evidence to understand how climate change will affect these activities;
- prioritised between them;
- developed action plans for all our risks.

Annex 1 explains our methodology in full and Annex 2 sets out our assessment of risks and our plans to manage them.

Our risk assessment approach describes potential climate impacts on our objectives against four characteristics:

- Importance – how much the impact matters to us.
- Proximity – when our objectives, resources or delivery will need to change in response to climate change.
- Inertia – how quickly we can adapt.
- Resources – the effort we need to make to adapt.

We have compared risks using these characteristics to understand our priorities, which are shown below in Table 1. Annex 3 gives a full explanation of how we have prioritised our risks.

Our priority risks	Rationale
Inland flooding	These risks are likely to increase with climate change. We are already factoring climate change into our flood risk management approaches. Funding levels will need to increase in the future to maintain current levels of protection.
Coastal flooding and erosion	
Wildlife and habitats	
Water resources and quality	Climate change poses significant risks to water resources and quality. While we are already addressing them, our current approach might not be sufficient in the future.

Table 1 – Our priority risks

Our analysis shows that our ability to deliver many objectives is not at risk from climate change but we may need to change the way we work to achieve the same results. A good example of this is where we give technical advice to our partners, such as advice on flood risk to local authorities. Our ability to offer such advice is not itself at risk from climate change but we may need to change the advice we offer to reflect the potential impacts of climate change.

The rest of this report explains how we are managing our climate risks:

- Chapter 2 sets out the climate impacts we expect to see;
- Chapter 3 explains how we will adapt to our priority risks;
- Chapter 4 explains how climate change affects our other activities, and especially how we will respond in our climate-influenced work;
- Chapter 5 explains how our adaptation programme will drive activity.

The annexes that support this report give more detail on our risks and our adaptation plans for the next five years. The actions and risks set out in this report reflect our current duties and ways of working. Our risks and adaptation plans may change with:

- Government policy and legislation;
- Our resources and remit.

We will review our assessment and adaptation plans on a regular basis and update them when appropriate.

2 Present and future climate

Here we summarise the potential impact of climate change on the environment of England and Wales, paying special attention to the areas covered by the Environment Agency's responsibilities. We look first at the evidence for the current impact of climate change, and then review the projected change over the 21st century.

Climate change impacts in England and Wales

Climate change is already happening. Global average temperatures have risen by 0.8°C since the late 19th century, with a more rapid increase over the last three decades. It is very likely that human emissions of greenhouse gases caused most of this increase. Atmospheric concentrations of carbon dioxide are now 388 parts per million (ppm), up from a pre-industrial level of about 280 ppm.

The climate system is very complicated, with many different factors affecting the weather at any location. This means, for example, that it is possible to have an unusually cold winter in the UK while mean global temperatures are high: globally, the first six months of 2010 were the warmest on record. This climatic variability means that it is more difficult to detect and attribute change to local climate trends than global trends. Despite this, we can see recent trends in the climate of England and Wales that affect the natural environment.

Central England temperature has risen by about 1°C since 1970. Average sea surface temperatures in UK coastal waters have risen in the last three decades by about 0.7 °C. Our monitoring data suggest that river water temperatures in England and Wales warmed at an average rate of 0.3 °C per decade between 1990 and 2007.

Sea levels have risen globally through the thermal expansion of water and ice melt. Changes in UK sea level are consistent with global observations. Average sea level around the UK rose by about 1mm/yr in the 20th century, corrected for land movement.

Rainfall is highly variable from month to month and season to season, and there is not yet evidence that UK rainfall is changing in response to climate change

Similarly, there is no evidence yet of a change in the frequency or duration of droughts in England and Wales. There were a number of significant droughts in the 20th century, but some droughts in the 19th century were longer and had a greater impact.

It is also not possible to say whether climate change is contributing to increased river flooding. There is some evidence of a trend towards increasing flows over the last thirty to forty years in northern and western areas, but in records over a longer timescale there is less evidence of any trends.

Animal and plant species are moving and changing in response to increasing temperatures. These changes are clearest in marine and coastal environments. In terrestrial and freshwater habitats the inability of species to move far, coupled with

the influence of land and water management, tends to obscure trends. There is some evidence that animals living in both terrestrial and freshwater environments have extended their range northwards and upwards. Natural events – like leafing and spawning – appear to be happening earlier in the season.

Projections of future change and impacts

We base our assessments of further climate change on the work of the UK Climate Impacts Programme, including the latest climate projections known as UKCP09. There is considerable uncertainty around future climate projections. This uncertainty arises partly because it is not clear how greenhouse gas emissions will change this century, but also because the climate system is complicated and some aspects are poorly understood. For the UK, there is confidence that temperatures will rise, but changes in rainfall patterns and volumes are much less certain. This uncertainty means that we prefer flexible and robust adaptation options that can cope with a wide range of future climates, as we set out in this report.

Over the rest of the century, temperatures are expected to rise everywhere, with the greatest increases in southern England. There may be little change in average annual rainfall, but more rain may fall in winter, with less rain in summer, particularly in the south of England. Coupled with increased temperatures, this may lead to much lower average summer river flows, but there may also be a significantly increased risk of flooding as more rain comes down in heavier bursts. River and lake water temperatures are likely to continue to increase broadly in line with air temperatures.

Sea level rise will increase coastal flooding and erosion. Under current projections of sea level rise, the coastal floodplains of the south-east and east coast of England would experience the greatest increased probability of flooding. There is a huge diversity of coastal environments and morphology, which will lead to very local variations in coastal change, but climate change is very likely to increase erosion rates with the most severe erosion occurring in the east of England.

By the late 21st century, the potential range of many European plant species may shift several hundred kilometres north. Freshwater and marine ecosystems will change in response to climate change, but there is still much to learn about how individual species and ecosystems will change.

3 Managing our priority risks

Our risk assessment shows that three areas of our work are particularly at risk from climate change and need to be priorities for our adaptation programme:

- flooding and coastal erosion
- water resources and quality
- wildlife and habitats.

This chapter sets out our objectives and adaptation plans in these areas. Annex 2 gives more detail on these risks and plans.

Flooding and coastal erosion

Our responsibilities

The Environment Agency has had a strategic overview role in England for all sources of flooding since 2008. We lead, advise on and coordinate planning and management to address all sources of flood risk and have an overview role for coastal erosion. The Welsh Assembly Government has overall responsibility for managing flood and coastal erosion risk in Wales with the Environment Agency responsible for managing flooding from inland main rivers and the sea.

The Flood and Water Management Act 2010 has come into force and is expected to be fully implemented by 2012. It gives the Environment Agency responsibility for managing main river and sea flooding while local authorities will be responsible for managing surface water, groundwater and ordinary water course flooding on a local basis, along with coastal erosion.

In managing flood risk, our objectives are to:

- work with our professional partners and the public to manage risk and reduce the probability of flooding;
- reduce the consequences of flooding;
- make sure that we, our professional partners and the public understand flood risk;
- provide environmental benefits through our flood management programme.

Climate risks to our flood and coastal erosion objectives are priorities for our adaptation programme. We need to continue to build on the actions we have already taken to manage them effectively.

Inland flooding

Flooding is one of the most visible and destructive effects of extreme weather. It can have devastating consequences, threatening people's lives, homes, possessions, businesses, the wider economy, utilities, transport and the natural environment. We expect inland flood risk to increase throughout the century as climate change influences rainfall patterns. We expect significantly more rain to fall in the winter and more of it to fall in short and heavy bursts. Heavier downpours are also likely in the

summer. These changes may increase both the frequency and duration of river flooding, leading to more severe impacts.

The impacts of river flooding depend on the vulnerability of people, properties, infrastructure and the environment. Our recent assessments of flood risk from rivers and the sea in England and Wales have documented that important infrastructure and public services are currently in flood risk areas:

- Water and wastewater treatment works and pumping stations are particularly at risk, since they tend to be located near rivers. We estimate that over 55 per cent of these sites in England and 80 per cent in Wales are in flood risk areas.
- About 7,000 electricity infrastructure sites, some 14 per cent of all in England, are also at flood risk. In Wales, the figure is 800 sites (22 per cent).
- We estimate that 10 per cent of main roads in England are at flood risk and 11 per cent in Wales. For railways the figures are 21 per cent and 33 per cent respectively.

The risks on the coast

The coastline of England and Wales is continually changing, with cliffs, sand dunes and mudflats shifting. Through our strategic overview role in England we aim to join up coastal management activities to ensure effective management of flooding and erosion risk. Large parts of the coast are at risk:

- England has approximately 4,500km of coastline, of which 60 per cent is at risk of flooding and 40 per cent at risk of erosion
- Wales has approximately 1,500km of coastline, of which 51 per cent is at risk of flooding and 49 per cent at risk from erosion
- Across England and Wales, 91 per cent of the coastline at risk of flooding has flood (sea) defences that reduce the frequency of flooding (mostly protecting land against a 1 in 200 year event)
- Most of the undefended flood plain is made up of saltmarsh or other land that benefits from flooding and also provides a buffer for coastal processes.

The latest science indicates that sea levels will continue to rise as a result of thermal expansion of the oceans, increasing the frequency and height of extreme high tides. Changes to storm surge magnitude and frequency may play a part although Met Office models do not suggest this at this time.

Sea level rise will increase coastal flooding and erosion and changes in rainfall will have an impact on cliff stability. Under current projections of sea level rise, the coastal floodplains of the south-east and east coasts of England would experience the greatest increased probability of flooding. Sea level rise also leads to greater wave energy incident on the coasts, potentially increasing erosion. Coastal environments and morphology are diverse and we expect climate-related changes such as sea level rise and increased winter rainfall to increase cliff erosion and instability with the most severe erosion occurring in the east of England.

Climate changes may also impact on the way we construct and maintain our flood and erosion defences. In particular, increased coastal erosion and wave action may disrupt our asset maintenance and construction programmes.

The action we are taking

We are taking action to ensure we have a sound evidence base and that the latest research and engineering evidence is available. We make sure that that we use this evidence to inform our decisions, actions and our work with all our partners. We are:

- using the latest set of climate projections to understand how river flows may change;
- monitoring changes in river flows to compare the trends observed by our river gauges with our predictions;
- improving our ability to differentiate the effects of climate change from natural variations in rainfall and river flows;
- improving our understanding of the processes that influence coastal erosion and coastal flooding by undertaking research and modelling, including using the UKCP09 projections where appropriate;
- assessing the impact of climate change on reservoir safety.

On a day to day basis we will:

- continue to advise against inappropriate developments in areas at risk of flooding now and in the future. We are working with others to ensure that spatial planning guidance and practice fully address flood risk;
- continue to work with others to increase resilience to flooding;
- seek to understand the implications of climate change on our current estimates of future flood risk from rivers and reconsider our current management approach;
- continue to work with natural processes to tackle flood risk where it is appropriate and cost-effective to do so. This includes creating new wetlands and habitats that are resilient to climate change and can help to convey flood water away from people and properties;
- create new habitats to compensate for those lost as a result of sea level rise, coastal squeeze and erosion of the coast, where legally required. This also increases the potential for intertidal storage for estuary flood management and helps to dissipate wave energy;
- take a flexible approach in the development and implementation of flood risk management approaches including new defences and maintenance of existing ones to help us address uncertainties about the effects of climate change and appropriate responses. Action can be brought forward or put back depending on what actually occurs in practice compared with projections;
- take account of Government guidance when making allowances for future climate change in the design of structures and schemes;
- ensure that we consider the implications of changes to river flows and sea levels when designing new schemes and maintaining and modifying existing structures, including allowing for increased disruption to our construction and maintenance programmes;
- ensure that our incident management response standards and planning assumptions are kept under review to account for changes in climate;
- consider what additional funding may be needed to maintain and improve flood defence assets to cope with climate change

- consider the aesthetic acceptability of flood defences to communities in particular locations.

We work with a wide range of partners including Government departments, local authorities, land owners and managers and the owners, operators and occupants of commercial and residential property. We have a wealth of technical knowledge, practical experience and data and an important role to help others play their part in managing flood and coastal erosion risk.

- We will continue to raise awareness of all sources of flood and coastal erosion risk, including the implications of climate change, by working closely with those affected and those in a position to act.
- In Wales we have embarked on the “Flood Awareness Wales” community engagement programme. This represents a key strand of the Welsh Assembly Government’s approach to managing flood risk through developing greater community resilience.
- In England, the Floodwise flood warning programme and coastal engagement projects seek to increase public understanding of participation in, and action on flood and erosion risk management.
- We will provide data, guidance and technical advice to:
 - inform the development and implementation of legislation including the Flood and Water Management Act 2010 and the Flood Risk Regulations 2009;
 - enable our partners and those we regulate to consider the implications of climate change for flood risk, both inland and from the sea and for coastal erosion.

We have published guidance for the organisations that have been directed or invited to submit adaptation reports by Defra, using its powers under the Climate Change Act 2008. And we will continue to work closely with our professional partners (including local authorities) to implement Catchment Flood Management Plans and Shoreline Management Plans and coordinate local planning and delivery. We have developed coastal erosion information by assessing the impact of sea level rise and changes to winter rainfall using the UKCP09 projections.

Water

Our responsibilities

We are the lead government body for securing the proper use of water resources and enhancing and maintaining the quality of waterbodies in England and Wales. We:

- aim to ensure that the abstraction and return of water have no unacceptable impact on the environment or water users;
- aim to ensure that there is enough good quality water for people, businesses, industry and agriculture most of the time;
- publish information on the demand for water and available resources;
- aim to ensure that water is used properly and efficiently;
- ensure discharges from sewage treatment works, industry and businesses are of an appropriate quality;

- ensure that surface water, groundwater and coastal waters (up to three miles from the coast) are of an appropriate quality;
- implement EU Directives such as the Water Framework Directive by developing and implementing river basin management plans, and ensuring that all relevant water quality objectives and standards are met.

The risks we face

Water bodies are under pressure from population growth, urban development and land-use change. We expect climate change to increase the pressure by altering the frequency and distribution of rainfall, increasing temperatures and increasing the frequency and severity of extreme weather events. Higher temperatures will also increase evaporation and the demand for water. These effects are likely to be most severe where rivers are fed primarily by surface run-off rather than groundwater and therefore rise and fall rapidly in response to rainfall, as in much of Wales.

Climate change will therefore affect the demand for water as well as its availability and quality. Working at the catchment level we have assessed the implications of climate change for river flows using the 2002 climate projections from UKCIP. We are now working with Defra and WAG to update our approach. Our modelling suggests that, on average, natural annual flows could decrease, with large decreases in many rivers during summer and autumn months coupled with higher flows in the winter. These changes may put substantial pressure on surface and groundwater supplies and quality. Other research suggests that the frequency of severe droughts could increase and restrict the water available for wildlife, people, industry and agriculture.

Heavier rainfall and potentially increased storminess could increase runoff from agricultural land and urban areas and increase discharges from combined sewer overflows. Climate change, coupled with changes to land management activities and land use, could increase soil erosion, pesticide and fertiliser run-off and urban run-off, resulting in pollution of surface waters. In areas such as the South Wales Valleys where the underlying geology causes rapid runoff to waterbodies, we anticipate more acute pollution incidents during intense rainfall events.

Climate change is a priority risk to our objectives for ensuring secure, safe and sustainable water supplies and healthy waterbodies. We need to continue to act, including building on the actions we have already taken, to ensure we manage the risks effectively.

The action we are taking

As with flood risk, our actions to address the impacts of climate change on water fall under three broad headings: ensuring we have a sound evidence base; using it to change the way we do things; and sharing it with others.

In order to continue to develop our understanding of the implications of climate change and ensure that we have a robust evidence base we will:

- improve our understanding of the impact of climate change on the availability of, and demand for, water;

- work with others to assess how climate change will impact on the frequency and intensity of drought and security of water supplies;
- improve our understanding of how wildlife responds to changes in water flow and seasonal variations;
- model future flows to the 2050s, using UKCP09, to ensure consistent application in impacts assessments by us and our partners;
- monitor the effects of climate change and continue to review our monitoring networks to ensure that they are fit for purpose;
- understand greenhouse gas emissions in abstraction and wastewater collection and treatment and gather baseline energy/water-use data for agriculture, industry, power generation and other sectors;
- understand the benefits of retrofitting sustainable drainage systems (SuDS) to existing sewerage systems, where practicable;
- understand the implications of climate change on sewerage and wastewater treatment.

In managing access to water and safeguarding water quality we will:

- ensure that the appraisal process used for River Basin Management Plans under the Water Framework Directive considers climate change and that these plans are considered in water company Water Resources Management plans;
- continue to look at whole river catchments to determine how much water is available for people and the environment and in our work to maintain and enhance the ecological status of waterbodies;
- continue to manage access to water through abstraction and discharge permits to ensure that the environment is not being harmed;
- work with Defra and the Welsh Assembly Government to review our licensing regime to ensure it is adaptable to climate change;
- promote guidance on the construction and development of suitable new resource solutions and water efficiency;
- work with Defra and the Welsh Assembly Government to use current controls to tackle diffuse pollution effectively and propose new approaches where necessary;
- target our farm inspections and our range of regulatory interventions to tackle pollution;
- advise on flexible adaptation strategies for water resources infrastructure and water resources management.

Noting the many uncertainties relevant to our roles we will work closely with a range of partners to plan for the future. In particular we will:

- work with Defra, the Welsh Assembly Government and Ofwat to develop and evaluate options for future access to and allocation of water;
- advise and provide evidence to government departments, the Welsh Assembly Government, regulators and abstractors on how to improve water efficiency;
- update our guidance to water companies to reflect the pressures from climate change;
- advise large water users in industry, agriculture and the energy sector on ways to reduce water use. We will work with them to understand the impacts from

climate change, and develop sector-specific adaptation actions to minimise risks;

- work with the Energy Saving Trust to ensure that water and energy efficiency are considered together in future programmes;
- advise on water supply resilience and identify areas to improve the connectivity and integration of supplies;
- identify actions to increase the resilience of supplies that underpin food and energy security;
- advise on the need to change our regulatory approach where existing approaches fail to deliver the changes needed;
- review and modify our approaches to reduce the energy used to supply and treat water and to reduce greenhouse gas emissions.

Wildlife and habitats

Our responsibilities

We have wide ranging responsibilities for wildlife and habitats, although we are generally not the lead body for them. Our functions include:

- contributing to the UK Biodiversity Action Plan, the England Biodiversity Strategy, the Wales Environment Strategy, the Wales Fisheries Strategy and leading on some actions;
- conserving Sites of Special Scientific Interest and enhancing the biodiversity, cultural and recreational potential of land we own;
- assessing new permits we issue under the Habitats and Birds directives to check for impacts on Special Protection Areas, Special Areas of Conservation and Ramsar sites;
- implementing the EU Water Framework Directive to achieve good ecological status and conserving freshwater and migratory fish and their habitats;
- enhancing the economic potential and social value of migratory and freshwater fishing.

The risks we face

Biodiversity is already declining in the UK due to habitat loss and the impact of invasive non-native species. Climate change will put even more pressure on wildlife. Some species will be unable to survive in their current location and there will be limits on how much they can adapt by themselves. This will make it difficult or impossible for us to achieve our wildlife objectives.

Aquatic systems are likely to be amongst the most sensitive to a changing climate as drought, periods of high temperatures, floods and extreme rainfall are predicted to occur with greater frequency and severity. Low river flows and high temperatures during summer droughts could have particularly heavy impacts on fish populations.

The vulnerability of fish species to climate change depends on their habitat and life cycle. We expect coldwater and migratory species such as trout and salmon to be particularly affected. In some parts of the UK, we have already seen changes in water temperature lead to increased trout and salmon mortality and changes in their life-cycle, such as the size of fish and the timing of their migration. In the long term, it

may not be possible to conserve trout and salmon in all places. Eel populations have also declined in the last thirty years and it is possible that climate change is a contributory factor.

We expect that climate impacts on coarse fish such as bream and carp will be less severe. However, their ability to adapt depends on the speed of climate change and the robustness of their habitats. It will be more difficult for them to adapt if their habitats become fragmented or degraded by other pressures.

Non-native species may become invasive under climate change, which could further impact on the diversity and vulnerability of native freshwater fish.

The effect of these changes on angling is complex. Although we do not expect to see the sport decline as a whole, we may see significant impacts on trout and salmon fisheries. These have significant socio-economic and historical value in Wales and South East England in particular. We may also see a shift in the species that anglers fish for, as native species migrate and non-native species become established.

Climate risks to our wildlife and fisheries objectives are priorities for our adaptation programme and need urgent attention.

The action we are taking

Reducing pressures such as pollution is key to maintaining functioning ecosystems as the climate changes. The fewer pressures that plants, animals and habitats have to deal with the more resistant and resilient they will be. We will develop a landscape management approach to reduce pressures. We will:

- reduce temperature in selected rivers by working with our partners to increase bank-side shade (for example, by allowing trees to recolonise);
- work with others to achieve the best outcomes for river basins that we can;
- set temperature standards for coastal waters and estuaries to manage the impact of cooling water from power stations;
- contribute to early response and monitoring plans for non-native species;
- make space for the natural development of rivers and coasts;
- ensure that wildlife adaptation needs are addressed in permits;
- help fish migrate by tackling barriers and building fish passes into flood defence, hydropower and water pumping schemes;
- develop tools and guidance for conservation managers, including a tool for wetland managers to help them factor climate change into their work
- continue to work with natural processes to tackle flood risk where it is appropriate and cost-effective to do so. This includes creating new wetlands and habitats that are resilient to climate change and can help to convey flood water away from people and properties;
- create new habitats to compensate for those lost as a result of sea level rise, coastal squeeze and erosion of the coast, where legally required. This also increases the potential for intertidal storage for estuary flood management and helps to dissipate wave energy.

We will need to work closely with our partners to help wildlife adapt. In particular, we will need to work with government and conservation agencies to decide if our species, habitats and fisheries objectives should change with the climate. We will:

- work with conservation agencies to review and, if necessary, revise objectives for species and habitats to allow for inevitable climate impacts;
- explore how we can help freshwater species with poor dispersal capabilities reach alternative habitats (e.g. fish such as vendace and schelly);
- promote biodiversity adaptation measures to our customers and partners to aid the achievement of the Water Framework Directive objectives and those of the Habitats and Birds Directive and related legislation;
- work with customers and third sector organisations who share our goals to reduce pressures on wildlife and habitats and increase their resistance and resilience to climate change;
- continue to monitor fish stocks to identify changes in species health and composition (including invasive species) that may happen with climate change;
- assess the value of commercial and recreational fisheries as species composition changes, and monitor effects on angling and rod licence sales.

We may sometimes see periods of the summer where high temperatures and low rainfall lead to low river flows and warmer water temperatures. In such conditions oxygen levels in the water can fall and it may be necessary to rescue fish or oxygenate the water to help them survive. We may also need to reintroduce species to recolonise stretches where fish have died.

Where climate change could lead to the permanent loss of a habitat, we may need to consider relocating species that we are responsible for. We are exploring moving vendace and schelly from the Lake District to more suitable northerly locations in England and Scotland to ensure that the species do not become extinct and are more able to adapt to climate change.

One problem we face in helping wildlife adapt is that the evidence on impacts and adaptation measures is often uncertain. We will need to improve this evidence base to make sure that we are addressing problems effectively. We will work flexibly so that we can adjust adaptation measures if we need to. We will:

- adopt an adaptive management approach, where we implement flexible measures, monitor their effectiveness and adjust them as needed, including testing experimental approaches and through action-learning research;
- review good adaptation practice, external research and emerging literature;
- assess the vulnerability of species and habitats to help us target adaptation measures, particularly for salmonid fisheries.

4 Managing our other climate risks

Our risk assessment shows that parts of our business do not face significant risks but will need to adapt to achieve the same results they do now. These are:

- Regulating business and waste
- Land quality
- Recreation and navigation
- Sustainable places
- Maintaining business continuity
- Reducing our own carbon emissions

This chapter explains how we are responding to climate change in these areas of our business. Annex 2 gives more detail on the climate impacts we expect and our plans to respond to them.

Regulating business and waste

Our responsibilities

We work with local government and businesses to regulate activities with the potential to harm the environment:

- We ensure that waste is recovered or disposed of safely.
- We help local government develop and monitor sustainable waste plans.
- We issue environmental permits to help industry and businesses operate in ways that do not cause harm to people or the environment.
- We check to ensure that industry and businesses comply with their permits.
- We regulate radioactive discharges and disposals of radioactive waste.

The risks we face

Climate change should not directly affect our regulatory, advisory and support roles for industry and waste management, however it will influence how we carry out these duties.

We know that climate change is likely to affect the frequency and severity of extreme weather events, sea level rise, flooding and low river flows, as well as increasing temperatures. These impacts may increase the vulnerability of regulated sites and their emissions to the environment.

The action we are taking

We need to understand how climate change could affect regulated businesses and waste management sites and adjust our approach accordingly. We will:

- investigate the risks to regulated sites and their increasing vulnerability;

- assess the implications of the adaptation reports submitted by other reporting bodies, including utilities and public service providers;
- examine how we record information and monitor compliance to ensure that we can clearly identify any causal link between climate change and permit breaches or pollution incidents;
- investigate how improved site management can help to reduce vulnerability to climate change impacts.

We will ensure that the sites we regulate manage their climate risks by:

- considering climate change when reviewing permits, assessing operator compliance and issuing guidance to our staff and operators;
- ensuring approaches such as Best Available Techniques (BAT) take account of climate change;
- revising guidance on flood risk and environmental permitting regulations;
- investigating levels of awareness of risks and working with regulated businesses to help them adapt.

In May 2011 we will receive a revised safety case for the Low Level Radioactive Waste Repository. We have asked that climate change impacts on sites are addressed in the safety case and we will carefully review these.

Land quality

Our responsibilities

- We support Government policies and strategies on land resource protection such as Defra's Soil Strategy for England and the Welsh Assembly Government's Environment Strategy.
- We have regulatory duties for contaminated land, sewage sludge, nitrate vulnerable zones, silage and slurry.
- We use catchment-based approaches to tackle diffuse pollution and improve water quality and environmental objectives specified by the Water Framework Directive (see Chapter 3).

The risks we face

Climate change may increase pesticide and fertiliser run-off in agricultural catchments, affecting the quality of water bodies (see Chapter 3). Higher temperatures and lower rainfall in the summer may affect soil structure and moisture content, increasing the potential risk of sediment run off into rivers and other water bodies.

Climate change will not directly affect our ability to deliver our other regulatory, advisory and support roles for land quality.

The action we are taking

We will work closely with our partners to adapt land management by:

- advising government, trade organisations and other government agencies on ways to promote and enhance adaptation as part of the Common Agricultural

Policy, Rural Development Programme, Sludge Regulations, Biowaste Directive and Nitrates Directive;

- pursuing sustainable urban drainage systems under the provisions of the Water Framework Directive and the Flood and Water Management Act 2010;
- supporting the Rural Climate Change Forum;
- advising government on the need for regulations to allow for increased winter rainfall associated with the storage of slurry and dirty water, for example the Silage, Slurry and Agricultural Fuel Oil Regulations 2010.

And we will further develop our evidence base by:

- working with others to review climate projections and identify future impacts on water and land;
- using monitoring frameworks and research programmes to detect climate change impacts on water and land.

In the longer term, we may need to work with government to review whether the current approach to encouraging voluntary land use change through incentives and advice is sufficient in the face of climate change.

Recreation and navigation

Our responsibilities

We are the statutory navigation authority for:

- the Great Ouse river system, alongside the Nene, Stour, Ancholme, Glen, Welland and the Black Sluice;
- the non-tidal Thames;
- the non-tidal Medway, part of the Royal Military Canal in Kent and Rye Harbour;
- the River Wye (below Hay-on-Wye) and the Dee Estuary.

We maintain and improve navigation on these waters and licence boats using them. We also promote recreation on these waters and the land that we own by providing improved facilities for users.

In Wales, we support the Strategic Plan for Water Related Recreation.

The risks we face

We expect climate change to make it more difficult to maintain waterways. Low flows can make it difficult for boats to pass through locks and high flows could increase bank-side erosion, damage infrastructure or be unsafe for river users. Higher temperatures are likely to increase plant growth and algal blooms.

We expect climate change to alter the recreational use of the land and water we manage. In the short term, we may see more people using them during warm weather, particularly if domestic tourism increases. In the longer term, extremely high or low river flows could limit safe and pleasant recreation. Low river flows during summer droughts could affect wildlife and reduce opportunities for angling.

The action we are taking

We will work with other navigation authorities to keep waterways open through dredging and managing weed growth. Drought conditions present problems for us and we will need to manage minimum flows and levels to protect wildlife while keeping waterways open for boats as far as possible. Should risk of drought conditions increase we will develop practices to seek to maintain a minimum flow and manage lock movements.

We will review the recreational facilities we provide on the land and waters we manage to make sure they can be used safely.

The pressure on waterways from climate change could lead to conflict and competition between users. We will help to resolve problems where they arise.

We will improve our evidence base by:

- evaluating emerging evidence on high river flows, increasing evaporation rates, vegetation growth, spread of invasive non-native species and algal blooms;
- using climate projections of river flows to understand how low flows could affect the usability and maintenance of the navigable waters for which we are responsible;
- reviewing data on strong stream flows and 30-day duration mean flows to find trends that could affect maintenance, asset management and the advice we give on strong streams to warn river users.

Sustainable Places

Our responsibilities

We work with local authorities and local partnerships to progress key environmental issues, to ensure that new development does not affect environmental objectives and to increase the resilience of existing developments. This includes work with planning authorities to ensure that local plans take account of environmental constraints and future climate change risks.

The risks we face

Our responsibilities towards sustainable places are not sensitive to climate change but we have an opportunity to help others adapt and consider climate change in their work.

The action we are taking

We will work with partners to promote adaptation, including:

- local authorities as part of our partnership approach to address environmental risks such as flooding and water stress;
- emerging Local Enterprise Partnerships in England to provide information and evidence on environmental constraints and future climate risks;
- policy makers, developers and other partners to provide evidence on sustainable building standards addressing climate change risks;

- planning authorities to ensure that spatial strategies (local, sub-national and the Wales Spatial Plan) account for climate risks;
- the Infrastructure Planning Commission (and successor body) to highlight climate change to infrastructure developers;
- governments in England and Wales to help advise planners and developers on using the UKCP09 climate projections.

Environmental assessments offer an opportunity to promote adaptation. We will:

- use our role as a statutory consultee to recognise climate change in Strategic Environmental Assessments and Environmental Impact Assessments;
- update our guidance on Strategic Environmental Assessments to include climate change;
- advise government so that climate change is included in Environmental Impact Assessment guidance.

Business continuity and managing our facilities

Our responsibilities

Like any organisation, we need to make sure that we have the facilities and systems in place to support our activities. As a Category 1 responder under the Civil Contingencies Act we also have a legal requirement to be able to deliver certain critical services at all times, such as flood warnings. To do this we need:

- suitable buildings, depots, vehicles and equipment;
- to mitigate the impact of unforeseen events so that we can maintain our operational response and meet the requirements of the Civil Contingencies Act;
- to safeguard our staff, systems and property from disruption through contingency planning and alternative ways of working.

The risks we face

We expect more extreme weather events as the climate changes and these could disrupt our own operations and those of our suppliers. Increased frequency and severity of extreme weather could mean that our incident management and response capabilities need to be more robust. If one of our key sites is affected by a business continuity emergency, we have contingency arrangements in place to deliver our critical services from another site.

The action we are taking

We are managing the impact that weather and climate have, or could have, on our operations. Our plans include:

- analysing the vulnerability of our facilities and buildings (for example, to flood risk) to determine which could be most affected by climate change;
- managing potential disruption to services (for example our utilities supplies) by understanding our vulnerabilities and putting systems in place to manage climate change incidents (e.g. emergency generators for critical systems);

- considering climate change in our long-term incident management planning and in our contingency planning, notably for flood risk;
- considering a wider range of possible climate impacts on our activities and in planning to provide suitable facilities for our staff;
- building greater resilience into our third party supply chain by considering climate risks in our procurement processes;
- making sure that our suppliers manage their own resilience to climate change and confirm that they will prioritise maintaining their service to us.

Reducing carbon emissions

Our responsibilities

We aim to play our full part in helping England and Wales meet greenhouse gas emissions targets in ways that minimise other environmental impacts, including running the EU Emissions Trading System and the CRC Energy Efficiency Scheme.

We also plan to reduce our own carbon emissions by 33 per cent by 2015 from 2006-07 levels.

The risks we face

Our objective to help England and Wales meet greenhouse gas targets is not sensitive to climate change but we can promote adaptation in the design of low carbon technologies.

There is negligible climate risk to our target to reduce our own carbon emissions by 2015. In the longer term, the risks could be greater, for example the impact of extreme weather events on the need to pump water for flood risk and drought management.

The action we are taking

We will ensure that our mitigation activities consider the sustainability of low carbon technologies, and incorporate the need for climate change adaptation in their design and delivery (e.g. hydropower, biomass, anaerobic digestion, and ground source heat pumps).

5 Our adaptation programme

The risk assessment and action plans that underpin this report give us confidence that we are taking the right actions to manage the climate risks we face now and in the future. They show that:

- Climate change affects much of what we do.
- Our priority risks relate to flooding and coastal erosion, water resources and quality, wildlife and habitats. We are already making good progress on the actions we need to take to manage these risks.
- We need to manage specific risks in other areas of our business and adapt how we work to achieve the outcomes we want – we have plans in place to do this.
- Partnership working is essential for adaptation and we are working closely with the UK Government, the Welsh Assembly Government, local government, local communities, business and the third sector.
- Many of our climate risks interact and need to be managed in an integrated way – we are well placed to do this effectively.
- We will continue to develop our evidence base to improve our understanding of risks and advise others. We will update our risk assessment and adaptation plans as our evidence improves or our remit changes.

We are already implementing the actions set out in this report. The four-way characterisation of our climate risks gives us a way of comparing the implications of climate change for everything we do and we can use this information to take decisions on our immediate, and longer-term, priorities. We will implement a formal adaptation programme based on the analysis presented here. It will:

- be sponsored by one of our Directors;
- ensure that we prioritise our actions to address climate risks in the priority areas listed above; that we take appropriate action to mitigate other specific risks and that we monitor changes to all our risks over time;
- continue to contribute to the UK Government's Adapting to Climate Change Programme, hosted by Defra, and to the development of the Welsh Assembly Government's Adaptation Framework;
- monitor implementation of our plans and report on our progress;
- identify and share good practice approaches to managing climate risks;
- ensure that our staff have the knowledge, skills and tools they need to address climate change and make this available to our partners as well;
- ensure that our research and analysis is coordinated both internally and with our partners;
- review and update our assessment as our understanding improves or our objectives change.

We believe our adaptation programme puts us in a good position to help the Government deliver its own National Adaptation Programme, due in 2012.

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Managing the environment in a changing climate

A report to Defra and the Welsh Assembly Government in
response to a direction to report under the provisions of the
Climate Change Act 2008

November 2010

Annex 1 - Methodology

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Introduction

This is an annex to our report *Managing the environment in a changing climate*, which sets out our climate risks and adaptation plans in response to a direction under the Climate Change Act 2008 from the Secretary of State for Environment, Food and Rural Affairs and the Welsh Ministers. It should be read together with the main report and the other annexes to understand the approach we have taken, our climate risks and adaptation plans.

This annex explains the methodology we have used to assess our climate risks and develop adaptation plans.

Rationale

We want to embed adaptation in our organisation so that it is at the heart of everything we do. Under our adaptation programme, our departments:

- work with our Evidence Directorate to develop climate evidence to support their needs
- are responsible for developing and delivering their own adaptation plans
- address climate change and adaptation in their decisions
- support strategic adaptation planning for the organisation (such as this assessment and report).

All our departments have done climate risk assessments and developed action plans before this assessment. However, the climate evidence they have available varies according to their work and exposure to climate risks. Departments such as Flooding and Coastal Erosion, where climate change is a key operational consideration, have detailed and quantitative evidence based on climate projections and environmental risk models. Departments such as Recreation, where climate change is not a significant operational risk, have a good understanding of the headline significance of climate projections but do not need detailed or quantitative impact studies. This variation in climate evidence is appropriate for our organisational needs but needs to be considered when undertaking a strategic and comparative risk assessment such as this.

The purpose of this assessment is to make a strategic comparison of climate risks. More specifically, we want to know:

- if climate change puts at risk our ability to deliver organisational objectives with current resources and delivery
- the relative importance of these risks.

This strategic assessment draws together climate evidence already available in our organisation. As we have noted, the detail and quality of this evidence varies between departments according to their needs. In some cases, such as flooding, we have a lot of evidence, indeed more than we need to draw general conclusions about the importance of their climate risks and the priority they need to be given in our adaptation programme. This assessment does not need to reproduce all the evidence

we hold on our climate risks, but does need to summarise it to allow systematic comparisons to understand our priorities.

The methodology set out here focuses on the 'big picture'. It uses a strategic risk characterisation framework to summarise existing evidence and compare risks. This complements the more detailed risk and impact assessments that we make at an operational level.

Our aim to embed adaptation rather than treat it in isolation also has implications for how we identify and appraise adaptation options in this assessment. In many cases, the adaptation responses identified here are *commitments* to embed adaptation in a future decision and do not prejudge the outcome of that decision itself. In some cases, those commitments have already been made in existing strategies.

For example, we commit to manage the impact of water abstraction on the environment and water users by 'working with Defra, the Welsh Assembly Government and Ofwat to develop and evaluate options for future access to and allocation of water' (see Annex 2). Clearly it is neither practical nor desirable to identify and evaluate those options in this assessment as it is a much wider decision (that is not necessarily for us to make alone).

Similarly, we have not carried out formal cost-benefit appraisal or stakeholder consultations on the adaptation plans set out in this report. We will instead carry these out during our normal operations as those decisions arise. We have however indicated broad adaptation costs in this report where it is possible to do so, although in some cases there is no clear separable adaptation component to an action.

England, Wales and spatial variation of risk

Climate impacts will vary across England and Wales due to local weather patterns and environmental factors. This regional variation will be important for some of our risks and our adaptation response for these will need to be tailored to local conditions. For example, we expect summer droughts to be more serious in south-east England than north-west England due to low rainfall and high demand for water.

Other climate risks will either not vary significantly across the country or will be so dependant on local factors that clear trends are indiscernible. For example, risk to individual Sites of Special Scientific Interest will depend on local climate, environment and the specific needs of the species present. It is difficult to generalise how such risks vary at a regional or national scale. Similarly, one of our objectives is to promote the proper and efficient use of water and there is little reason to suppose that this will have a clear spatial trend.

Spatial variation is therefore important for some risks but also highly complex and dependent on the risk in question and specific local factors. Such a level of detail and complexity is unnecessary for this strategic assessment, where we are interested in establishing which of our organisational objectives are at most risk. We will of course need to consider spatial variation when considering local adaptation needs, such as flood defences, but it makes more sense to carry out such detailed modelling during the course of our normal operations.

However, we do need to particularly consider differences in risk between England and Wales, which may arise due to:

- spatial variation in climate or the environment
- different organisational objectives between England and Wales due to devolved policy
- different adaptation responses between England and Wales due to devolved policy.

We have recognised this in our assessment by:

- allowing risks to be rated differently for England and Wales if appropriate
- framing the assessment around separate organisational objectives for England and Wales where appropriate to devolved policy
- proposing different adaptation responses for England and Wales where appropriate to devolved policy.

Methodology

Our approach follows the UKCIP, Defra and Environment Agency framework (2003, Figure 1).

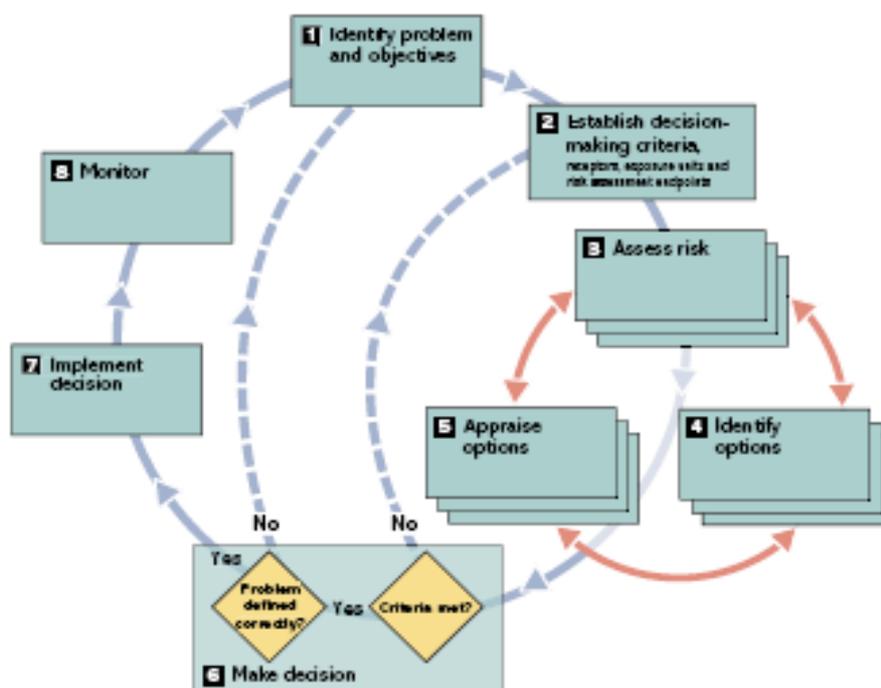


Figure 1 – Our assessment approach

This approach is consistent with Defra and the Environment Agency’s framework for environmental risk management (Defra et al. 2000) and also draws on frameworks for strategic risk analysis (Environment Agency 2007, WGBU 2000).

The individual steps of our approach are described below.

1 Identify problem and objectives

Our statutory direction asks us to assess climate impacts on our statutory and non-statutory duties. Statutory guidance explains that this should be taken to include functions, missions, aims and objectives.

For the purposes of this assessment, we have interpreted our objectives to cover our regulatory, operational, advisory and partnership roles.

Box 1 shows the 58 objectives we have used for this assessment. Note that these are intended to represent the range of activities carried out by the Environment Agency for the purposes of this assessment. They are not a definitive list of our statutory duties nor a complete list of our regulatory duties.

Box 1 – Organisational objectives used for this assessment

Inland flooding

- 1.1 We, our professional partners and the public will have a greater understanding of inland flood risk.
- 1.2 We will work effectively with our professional partners and the public to manage risk and reduce the probability of inland flooding.
- 1.3 We will reduce the consequences of inland flooding.
- 1.4 Our inland flood management programme provides environmental benefits.

Coastal erosion and flooding

- 2.1 We, our professional partners and the public will have a greater understanding of coastal flood and erosion risk.
- 2.2 We will work effectively with our professional partners and the public to manage risk and reduce the probability of coastal flooding and erosion.
- 2.3 We will reduce the consequences of coastal flooding and erosion.
- 2.4 Our coastal flood and erosion management programme provides environmental benefits.

Water resources

- 3.1 We will aim to ensure that abstraction has no unacceptable impact on the environment or water users.
- 3.2 We will aim to ensure that there is enough good quality water for people, businesses, industry and agriculture most of the time.
- 3.3 We will publish information on the demand for water and available resources.
- 3.4 We will aim to ensure that water is used properly and efficiently.

Water quality

- 4.1 We will monitor sewage treatment works and trade discharges, as well as the quality of freshwater, groundwater and tidal waters (up to three miles from the coast).

Box 1 – Organisational objectives used for this assessment (continued)

- 4.2 We will implement the EC Water Framework Directive and other EC directives; to ensure that all relevant water quality standards are met.

Regulated business

- 5.1 We will ensure that waste is recovered or disposed of in ways which protect the environment and human health, by regulating waste management operations (including collection, transport, treatment, storage and disposal) and enforcing waste management controls in a nationally consistent manner.
- 5.2 We will provide comprehensive monitoring data (in conjunction with local authorities, as necessary) to enable the amount of waste arising and the final disposal method to be tracked and recorded for each significant waste stream.
- 5.3 We will assist regional bodies and local government in developing waste plans and strategies that reflect the waste hierarchy and the national waste strategy.
- 5.4 We will encourage and determine applications for new and existing installations within the timescales laid down in the EP Regulations.
- 5.5 We will set permit conditions in a consistent and proportionate fashion based on Best Available Techniques and taking into account all relevant matters including: sectoral and site-specific compliance costs; and the resulting local, national and trans-boundary environmental benefits.
- 5.6 We will control industry discharges to watercourses through the powers provided by the Environmental Permitting Regulations 2010.
- 5.7 We will work with local authorities towards delivering the objectives of the National Air Quality Strategy and to support the development of regional air quality strategies.
- 5.8 We will regulate aerial and liquid radioactive discharges, and solid radioactive waste disposal, in accordance with statutory duties, statutory guidance and Government policy, and the security of radioactive sources used in non nuclear industry.

Land quality

- 6.1 We will act as advisors to Government on development of, or revision to, policies, strategies and legislation to ensure that they provide the right measures for effective resource protection and climate change adaptation and mitigation, for example review of the Sludge (Use in Agriculture) Regulations 1989; the Biowaste Directive; the proposed Soil Framework Directive; Contaminated Land Policy; the Rural Climate Change Forum; the review of the Common Agricultural Policy and Rural Development Plans for England and Wales.
- 6.2 We will support and contribute to the successful implementation of Government policies and strategies for example Defra's Soil Strategy for England, the Welsh Assembly Government's Environment Strategy or the sustainable use of soil policy.
- 6.3 We will carry out regulatory duties, for example the Contaminated Land (England and Wales) Regulations 2006; the Sludge (Use in Agriculture) Regulations 1989; Nitrate Pollution Prevention Regulations 2008; the Water Resources (Control of Pollution), Silage, Slurry and Agricultural Fuel Oil (England and Wales) Regulations 2010; Cross Compliance.

Box 1 – Organisational objectives used for this assessment (continued)

- 6.4 We will develop and support catchment based approaches to tackle diffuse pollution and improve water quality and other environmental objectives specified by the Water Framework Directive (that is, support the Environment Agency to fulfil our Competent Authority role for River Basin Planning). For example: pollution reduction programmes; Voluntary Initiative on Pesticides; the England Catchment Sensitive Farming Delivery initiative and Environment Agency Wales Catchment initiative; and the Campaign for the Farmed Environment.
- 6.5 We will produce, or collaborate on, climate change and resource protection guidance for urban and rural land managers. Promoting practices and incentives that encourage land managers to protect soil and water, or clean up contaminated land. For example Farming for the Future fact sheets; thinksoils; Good Farming – Better Environment; and the sustainable management of contaminated land guidance.

Conservation and ecology

- 7.1 We will contribute to the implementation of the UK Biodiversity Action Plan, the England Biodiversity Strategy and the Wales Environment Strategy, and in particular the delivery of those actions for which the Environment Agency has lead responsibility.
- 7.2 We will further the conservation of Sites of Special Scientific Interest and in managing our own land, to enhance its biodiversity, cultural and recreational potential.
- 7.3 We will ensure that all Environment Agency consents where we cannot conclude no adverse effect on the integrity of a Special Protection Area, Special Area of Conservation or Ramsar site are reviewed and either affirmed, modified or revoked as appropriate, and that any new consents are dealt with in accordance with the requirements of the Conservation of Habitats and Species Regulations 2010.
- 7.4 We will ensure that ‘environmental damage’ to protected species and natural habitats, and any imminent threat of such damage, in inland waters or from EA-regulated activities, is identified and addressed in accordance with the requirements of the Environmental Liability Directive.
- 7.5 We will implement the EC Water Framework Directive via the management of biological pressures, development and ownership of monitoring tools, and overseeing the design and implementation of Programmes of Measures.

Fisheries

- 8.1 We will ensure the conservation and maintain the diversity of freshwater fish, salmon, sea trout, eels, lamprey and smelt, and to conserve their aquatic environment.
- 8.2 We will enhance the contribution migratory and freshwater fisheries make to the economy, particularly in remote rural areas and in areas with low levels of income.
- 8.3 We will enhance the social value of fishing as a widely available and healthy form of recreation.

Box 1 – Organisational objectives used for this assessment (continued)

- 8.4 We will deliver the Wales Fisheries Strategy in collaboration with the Welsh Assembly Government.
- 8.5 We will implement the EC Water Framework Directive via the management of biological pressures, development and ownership of monitoring tools, and overseeing the design and implementation of Programmes of Measures.
- 8.6 We will contribute to the implementation of the UK Biodiversity Action Plan, the England Biodiversity Strategy and the Wales Environment Strategy, and in particular the delivery of those actions for which the Environment Agency has lead responsibility.
- 8.7 We will ensure that ‘environmental damage’ to protected species and natural habitats, and any imminent threat of such damage, in inland waters or from EA-regulated activities, is identified and addressed in accordance with the requirements of the Environmental Liability Directive.

Navigation

- 9.1 We will maintain and improve navigation on the navigable waters (mostly rivers) for which the Environment Agency has responsibility and licence boats using these waters as a statutory Navigation Authority; to maintain its assets in a condition which ensures the safe use of its waterways.
- 9.2 We will promote urban and rural regeneration.

Recreation

- 10.1 We will promote greater recreation, in particular for the use of waterways we manage by all sectors of society, and provide improved facilities for users
- 10.2 We will manage our own lands to enhance their cultural and recreational potential.
- 10.3 We will work to deliver the Strategic Plan for Water Related Recreation in Wales.

Sustainable places

- 11.1 Better local environments enhance people’s lives and support a sustainable economy.
- 11.2 New and existing developments have a reduced environmental impact and well planned environmental infrastructure.
- 11.3 Spatial and economic planning meets environmental standards and objectives, and addresses climate change.

Climate change

- 12.1 We play our full part in helping England and Wales meet greenhouse gas emissions targets in ways that minimise other environmental impacts. This includes administering the EU Emissions Trading System and the CRC Energy Efficiency Scheme.
- 12.2 We help people and wildlife adapt to climate change and reduce its adverse impacts.
- 12.3 We will reduce our carbon emissions by 33 per cent by 2015 from 2006-07 levels.

Box 1 – Organisational objectives used for this assessment (continued)

Our business continuity and estates

- 13.1 We will provide suitable facilities (property, fleet and other assets) to support employees' roles and the delivery of our corporate strategy.
- 13.2 We will drive efficiencies in our working practices and ensure high use of our assets.
- 13.3 We will acquire land to deliver our functional objectives.
- 13.4 We will minimise and mitigate the effects of a disruption on the business from an unforeseen event, plus meeting the requirements of the Civil Contingencies Act.
- 13.5 We will provide suitable safeguards to ensure our people, systems and property work effectively in the future. To find more efficient ways of coping with disruption, through contingency planning, alternative ways of working and so on.

Note that we have numbered objectives consistently throughout our assessment so they can be tracked easily.

2 Establish decision-making criteria

This is a strategic assessment to characterise our risks and inform an adaptation programme. Our decision-making criteria have therefore been selected to help us prioritise our risks.

From a strategic, organisational perspective, priority is largely determined by four factors:

- Proximity - when our objectives, resources or delivery plans need to change in response to climate change.
- Importance – how much the impacts on each objective matter to us.
- Inertia – how quickly we can adapt.
- Resources – how much effort adaptation requires.

Proximity affects a risk's priority because more imminent risks are more urgent than distant ones.

The importance of a risk's impacts affects its priority because some impacts matter more than others. This can be either a quantitative difference (for example, Risk A harms more people than Risk B) or a qualitative one (for example, if one objective is considered more important than another).

Inertia refers both to how quickly we can adapt and how easily we can change that adaptation response. This affects risk priority when we need longer to get ready for some risks than others. For example, some measures take a long time to implement (for example infrastructure) or require long-term commitments (for example shoreline management plans).

Resource requirements are important where we need to reassign or raise significant money or manpower to manage risks. All else being equal, risks with high resource requirements are of more concern than those with low requirements.

3 Assess risk

Risk screening

We have screened out objectives that are not sensitive to climate change to concentrate the assessment on those that are.

Objectives can be:

- sensitive to climate and included in the assessment;
- insensitive to climate and excluded from the assessment;
- influenced by climate and excluded from the assessment but noted for the adaptation programme.

Sensitive objectives are those whose achievability depends on climate change. For example, Objective 1.2 (We will work effectively with our professional partners and the public to manage risk and reduce the probability of inland flooding) is sensitive as climate change will affect the probability of flooding. Sensitive objectives are climate risks.

Climate influenced objectives are those whose achievability does not depend on climate change but where we might want to work differently as a result. This applies in particular where we work with others to secure environmental outcomes. In such cases, our objective is usually a process, such as regulation, rather than a specific outcome. For example, Objective 5.4 (We will encourage and determine applications for new and existing installations within the timescales laid down in the EP Regulations) is climate influenced because our regulatory processes are not at risk but we might need to change them to achieve the same outcomes as the climate changes.

Climate influenced objectives are often either indirect risks to us or opportunities to work with others.

Insensitive objectives are not affected by climate change. For example, our requirement to provide data on waste disposal is not affected by climate (Objective 5.2).

Conceptual models

A conceptual model describes the relationship between a hazard and an endpoint at risk. It is a useful way of explaining which processes and outcomes we are thinking about in our assessment.

We have used the DPSIR (Driver-Pressure-State-Impact-Response) approach to explain how each sensitive objective is affected by climate drivers. We have also included key non-climate drivers where relevant. Although these conceptual models describe plausible mechanisms by which climate or other drivers may affect our objectives, they do not quantify or prioritise them, nor do they make any comment on the importance of impacts caused.

Characterising risks

We characterised risks to our objectives using four characteristics:

- Impact proximity
- Impact importance
- Response speed (inertia)
- Response resource requirements

We collected evidence on impacts and responses including:

- the size of impacts on the environment;
- the extent to which these affect each objective;
- uncertainty and range of estimates of impact;
- when climate impacts on the environment and our objectives could become noticeable;
- when climate impacts on the environment and our objectives threaten achievement of our objective under business as usual;
- spatial variation in impacts where relevant;
- potential opportunities.

The proximity of impacts was rated as either:

- Now – current resources and delivery could already be potentially unsustainable.
- Short-term – current resources and delivery could be unsustainable by 2030.
- Medium-term – current resources and delivery could be unsustainable by 2060.
- Long-term – current resources and delivery could be unsustainable by 2100.

Note that the timing of climate impacts depends partly on emission scenarios, which diverge considerably in the latter half of the century. This means that risks rated with a proximity of now, short-term or medium-term are relatively insensitive to emission scenario. Risks that are most sensitive to emission scenarios will therefore all be classified as having a long-term proximity. This is a simple way of separating risks that are sensitive to emission scenario in the assessment, and avoiding the need to consider scenarios unnecessarily.

We evaluated potential impacts and responses against business thresholds by rating them as either:

- Severe – our objective could be unachievable with current resources and delivery and this could have major impacts on the wider organisation (for example, legal challenge or undermines licence to operate).
- Substantial – our objective could be unachievable with current resources and delivery and this could have some impact on the wider organisation.
- Moderate – our objective could be unachievable with current resources and delivery but this will have little or no impact on the wider organisation.

- Minor – there will be some impact on our objective with current resources and delivery.
- Negligible – there will be virtually no impact on our objective with current resources and delivery.

Note that these are ‘thresholds’ for the purposes of the statutory guidance.

The response speed (inertia) was rated as either:

- Long-term – longer than two corporate planning cycles (10+ years).
- Medium-term – within two corporate planning cycles (10 years).
- Short-term – within one corporate planning cycle (5 years).
- Rapid – within 2 years.

Resource requirements were rated as either:

- Major – we cannot fully adapt without significant additional external resources.
- Substantial – we cannot fully adapt without some additional external resources.
- Moderate – we will need to reallocate resources between departments.
- Minor – we can reallocate resources from within the same department.

Uncertainty, probability and confidence

Risk assessments should consider both the likelihood and magnitude of possible outcomes. However, it is difficult to formally separate likelihood and magnitude in a strategic climate risk assessment such as this because:

- climate change is dynamic so the likelihood and magnitude of impacts will vary progressively as climate change worsens;
- many environmental impacts of climate change are better understood as progressive trends (albeit with uncertain timing and scale) rather than stochastic risks (those that can be assigned a specific probability of occurrence);
- the assessment is framed around strategic organisational objectives that encompass many discrete outcomes with their own probability and magnitude, which are difficult to aggregate meaningfully.

We have found it difficult to reliably attach probability estimates to strategic ratings of impact and response and take the view that doing so would be misleading and in any case would not add much to the assessment since we are more interested in understanding the relative priority of risks rather than their absolute magnitude.

We have instead represented uncertainty in our assessment in two ways:

- by attaching confidence estimates to ratings of impact and response;
- by expressing uncertainty and variability in these ratings as ranges rather than point values.

Confidence in the evaluation of impacts was rated as:

- Very low – based on expert judgement or weak evidence only.
- Low – based on few, incomplete, inconclusive impact studies.
- Medium – based on expert interpretation of a number of (potentially conflicting) impact studies.
- High – based on impact studies that give a consistent picture but do not explore uncertainty fully.
- Very high - based on many impact studies that give a coherent picture and explore uncertainty fully.

Confidence in the evaluation of responses was rated as:

- Very low – we do not have sufficient understanding of the impact to be able to suggest any possible response.
- Low – we do not have a good understanding of our response.
- Medium – we understand the nature and scale of the response required (for example, change of policy, major legislative intervention and so on).
- High – we have scoped the feasibility of specific responses.
- Very high – we have scoped the feasibility of specific responses and have developed policy for best practice.

We have dealt with uncertainty and variability in impact, response and confidence by expressing ratings as ranges rather than a single value where appropriate. Ranges have been characterised as ‘best case’ and ‘worst case’ extremes and imply upper and lower estimates based on the presented evidence rather than formal scenario analysis (see Table 7 in Annex 3).

4 Identify options

We have identified adaptation actions for all our sensitive and influenced objectives over:

- the next year;
- the next 5 years (our corporate planning cycle);
- the long term in outline.

The actions we have identified are SMART:

- Specific to sensitive objectives;
- Measurable;
- Achievable;
- Realistic;
- Time-limited (and will be completed either in one year, five years or longer term).

In some cases, climate change presents opportunities to work differently or achieve desired outcomes. We have identified these where this is the case.

Each action has an identified owner who is responsible for its delivery, though these names are not given in Annex 2.

5 & 6 Appraise options and make decisions

It is important that adaptation actions are properly appraised to check that they are effective and offer good value. However, it is difficult to appraise the strategic actions identified here because:

- it is preferable to appraise them at the point of delivery and as part of our normal business processes (this also helps embed adaptation);
- many of the actions here are strategic commitments rather than specific proposals;
- there is often no distinct adaptation component to environmental decisions that can be appraised separately.

For these reasons, we will make sure that adaptation is properly embedded in our decision-making processes rather than appraised separately here.

However, we do recognise that appraisal is essential and needs to be done well. We have systematic guidance for appraising all potential schemes (for example flood management schemes) to get maximum value for money (in terms of benefits from reducing risks and consequences) from our Grant in Aid expenditures and to ensure their sustainability. We have a duty to follow relevant Government guidance in these appraisals, such as the HM Treasury *Green Book* and associated annexes on adaptation and managing public risk.

Stakeholders

We recognise that we need to work with others to adapt and many of our actions involve providing advice or partnership working. However, we have not consulted directly on the actions presented in this report because we are a public body and we need to consult on our adaptation actions in the context of discharging our duties rather than separately. We will therefore consult on specific adaptation actions during our normal operations. This will also help embed adaptation within our organisation.

It is also worth noting that many of the actions presented in Annex 2 are either strategic commitments to review working practice rather than specific proposals on what we might do differently, or are taken from existing plans that have already been widely consulted on.

7 Implement decisions

We will set up an adaptation programme to deliver the adaptation actions identified in this report including:

- research to better understand risks;
- actions to reduce risks;
- working and consulting with stakeholders;
- identifying and delivering opportunities from climate change;
- addressing barriers to adaptation.

Our adaptation programme will:

- be sponsored by one of our Directors;
- ensure that we prioritise our actions to address climate risks in the priority areas listed above; that we take appropriate action to mitigate other specific risks and that we monitor changes to all our risks over time;
- continue to contribute to the Government's Adapting to Climate Change Programme, hosted by Defra;
- monitor implementation of our plans and report on our progress;
- identify and share good practice approaches to managing climate risks;
- ensure that our staff and partners have the knowledge, skills and tools they need to address climate change;
- ensure that our research and analysis is coordinated both internally and with our partners;
- review and update our assessment as our understanding improves or our objectives change.

8 Monitoring

We will monitor adaptation progress and climate change by:

- establishing corporate adaptation indicators to track our programme;
- monitoring environmental change through our normal systems (for example, hydrometric monitoring).

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Managing the environment in a changing climate

A report to Defra and the Welsh Assembly Government in
response to a direction to report under the provisions of the
Climate Change Act 2008

November 2010

Annex 2 – Risks and adaptation actions

Introduction

This is an annex to our report *Managing the environment in a changing climate*, which sets out our climate risks and adaptation plans in response to a direction under the Climate Change Act 2008 from the Secretary of State for Environment, Food and Rural Affairs and the Welsh Ministers. It should be read together with the main report and the other annexes to understand the approach we have taken, our climate risks and adaptation plans.

This annex provides a tabular summary of the risk assessments and action plans compiled for our duties under twelve themes:

Inland flooding	4
Coastal erosion and flooding	10
Water resources	16
Water quality	22
Regulated business	27
Land quality	31
Wildlife and habitats	36
Navigation	50
Recreation	54
Sustainable place	58
Climate change and energy	61
Our business continuity and estates	66

Each summary consists of:

- (i) a conceptual model of the main drivers, pressures and impacts from climate change (for climate-sensitive objectives only);
- (ii) a characterisation of our climate change risks in terms of four key attributes (for climate-sensitive objectives only);
- (iii) a description of our forthcoming and completed adaptation actions and an indication of levels of resource;
- (iv) a description of potential opportunities associated with climate change;
- (v) a list of key references for our assessment of potential climate change impacts.

A key to the definitions of those key attributes and resource estimates is provided below.

Risk Characterisation

Attribute	Score	Definition
Importance <i>The extent to which climate change could compromise delivery</i>	Severe	Our objective could be unachievable with current resources and delivery and this could have major impacts on the wider organisation (for example, legal challenge or undermines licence to operate).
	Substantial	Our objective could be unachievable with current resources and delivery and this could have some impact on the wider organisation.
	Moderate	Our objective could be unachievable with current resources and delivery but this will have little or no impact on the wider organisation.
	Minor	There will be some impact on our objective with current resources and delivery.
	Negligible	There will be virtually no impact on our objective with current resources and delivery.
Proximity <i>When we need to take action</i>	Now	Current resources and delivery are already potentially unsustainable.
	Short-term	Current resources and delivery could be unsustainable by 2030.
	Medium-term	Current resources and delivery could be unsustainable by 2060.
	Long-term	Current resources and delivery could be unsustainable by 2100.
Resource <i>Effort needed to adapt</i>	Minor	We can reallocate resources from within the same department.
	Moderate	We will need to reallocate resources between departments.
	Substantial	We cannot fully adapt without some additional external resources.
	Major	We cannot fully adapt without significant additional external resources.
Inertia <i>How quickly we can adapt</i>	Long-term	Longer than two corporate planning cycles (10+ years).
	Medium-term	Within two corporate planning cycles (10 years).
	Short-term	Within one corporate planning cycle (5 years).
	Rapid	Within 2 years.

Confidence

Confidence in the evaluation of importance and proximity was expressed as:

- **very low** – based on expert judgement or weak evidence only;
- **low** – based on few, incomplete, inconclusive impact studies;
- **medium** – based on expert interpretation of a number of (potentially conflicting) impact studies;
- **high** – based on impact studies that give a consistent picture but do not explore uncertainty fully;
- **very high** – based on many impact studies that give a coherent picture and explore uncertainty fully.

Confidence in the evaluation of resource and inertia was expressed as:

- **very low** – we do not have sufficient understanding of the impact to be able to suggest any possible response;
- **low** – we do not have a good understanding of our response;
- **medium** – we understand the nature and scale of the response required (for example, change of policy, major legislative intervention etc);
- **high** – we have scoped the feasibility of specific responses;
- **very high** – we have scoped the feasibility of specific responses and have developed policy for best practice.

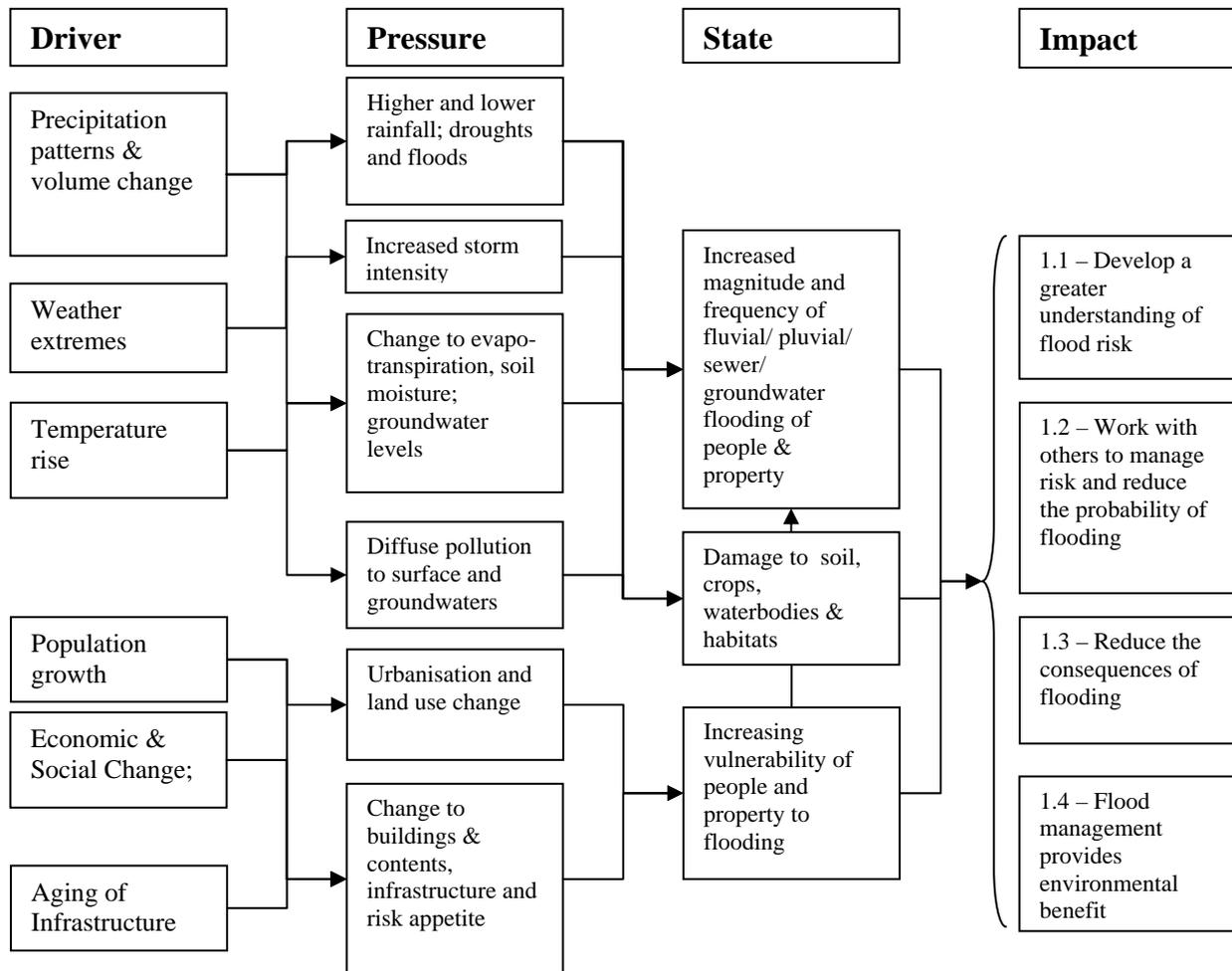
Costs

The indicative cost of actions is rated low (less than £50k), medium (£50-500k) or high (more than £500k). Where the costs of adaptation could not be disaggregated from normal business practice, total costs have been displayed in parentheses to indicate that adaptation is a sub-component of the proposed action. Costs rated as N/A

indicate that the proposed actions cannot be assigned an indicative cost given their strategic nature but where possible indicative costs will be assigned as these actions are developed further.

Inland flooding

Conceptual model of sensitive risks



Key evidence
- We have assessed the potential climate change impacts on river flood flows using UKCIP02/ UKCP09 projections, though we have not yet fully incorporated these into our flood risk models
- Our understanding of the characteristics of climate change risk, and the measures to manage risks and vulnerabilities have been developed through a number of Environment Agency, Defra and Office of Science and Technology studies and are incorporated in our Long term Investment Strategy
- We have undertaken our own research to understand when climate change may noticeably alter precipitation patterns and extremes. This is published in peer reviewed academic literature
- We rely on external research to help us better understand changes to extreme rainfall, which at present is not well represented in climate models, UKCP09 being an example

Risks and actions

1.1 - We, our professional partners and the public will have a greater understanding of inland flood risk.	
Impact	
	Rationale and uncertainty
Importance: Substantial	Current estimates of the risk from rivers have mostly increased as a result of better science and understanding of drivers and impacts on flood risk. We expect climate change to significantly change the quantum and spatial distribution of flood risk to people and property. This will challenge our ability to assess future inland flood risk.
Proximity: Short-term	<ul style="list-style-type: none"> We are confident that increasing temperatures will result in increasing winter rainfall totals and intensity. We are much less confident in changes to extreme summer rainfall. Change to river catchment response and flows will vary on location, and our understanding of this is still developing. We are also uncertain about non-climate factors around community and social change and the effects of very wide scale flooding. Climate models suggest we will be able to detect climate change increases in extreme events by the early 2020s. This is very dependent on our understanding and calculation of natural variability in rainfall, but we also know that climate models seem to be underestimating the changes to rainfall already recorded.
Confidence: High	
Response (to worst case impacts)	
Resource: Substantial	We need to understand how climate change will affect our understanding of flood risk, our ability to deliver flood forecasts and develop strategic, long term plans. We will need to communicate effectively with all our partners if we are to ensure a co-ordinated and sufficient response.
Inertia: Short-term	<ul style="list-style-type: none"> We will continue to adapt our work even though the uncertainty around climate change projections is significant. Use of risk-based approaches will enable this. We need to favour flexible solutions that don't foreclose the decisions that may need to be taken, and flexible plans that can be adjusted if a future begins to emerge that is different from the one we assumed at the start. We are working to put these concepts at the heart of our approach to adaptation.
Confidence: High	
Adaptation actions	
In the next year:	Costs
We are working to support Defra and the Welsh Assembly Government to understand how river flood flows may change in the future using UKCP09 projections.	M
We will continue to work with our professional partners to help them understand their risks using our Catchment Flood Management Plans to ensure co-ordination with the plans they are developing.	(L)
In accordance with Government policy we will seek to understand the implications on our current estimates of future flood risk from rivers and reconsider our current management approach.	(L)
We will improve our understanding of where and when climate changes will be distinguishable from natural variability in rainfall and river flows. This will help us prioritise work and effectively monitor for change.	M
In the next 5 years:	
We will implement better indicators to monitor change in river flows and to compare predicted climate change with the trends observed by our river gauges. This will help us re-evaluate our approach and seek to reduce the risks of under or over-adaptation.	M
We will revisit our strategic plans where suggested by climate change evidence and Government policy.	(L)
We will provide technical advice to our partners on representing climate change in their risk assessments.	(L)

We will provide technical advice to Defra, the Welsh Assembly Government and Lead Local Flood Authorities to enable climate change to be integral to achievement of Flood Risk Regulations, 2009.	(L)
We will further develop methods to ensure climate change is fully considered in flood estimation of current/ baseline conditions.	M

1.2 - We will work effectively with our professional partners and the public to manage risk and reduce the probability of inland flooding.

Impact

	Rationale and uncertainty
Importance: Substantial – Severe	Our National Flood Risk Assessment shows that a sizeable part of the important infrastructure and public services in England and Wales are in flood risk areas. This is especially so for water-related infrastructure that needs to be near rivers. We also expect climate change to significantly increase flood risk to people and property.
Proximity: Now	We expect the risk of inland flooding in the 2080s to increase by between approximately 4 and 6 times over present levels due to the impact of changes to precipitation. The effect in an urban conurbation protected by linear flood defences would be to increase the chance of flooding from 1 per cent in any given year to 6 per cent under a high emission scenario, for instance (Foresight Report, 2004). ¹
Confidence: High	We expect public scrutiny and challenge and need to plan adequately for flood risk over the long term. <ul style="list-style-type: none"> • Models suggest we will see a detectable increase in extreme events in the early 2020s. But many of our decisions are very long lived, so it is important that these consider climate change now. • There is uncertainty about the duration of asset deterioration although we can be certain that assets will deteriorate faster with climate change, for example erosion of soft defences and increased erosion / siltation rates during more frequent extreme events such as seen in Cumbria in 2009.

Response (to worst case impacts)

Resource: Major	This is the major focus of our inland flooding adaptation work. Whether providing new flood management assets, developing our modelling and mapping or through our leadership, we are putting climate change at the heart of what we do. <ul style="list-style-type: none"> • The eventual scale and spatial distribution of climate change impacts on inland flood risk are very uncertain. A complex set of variables interacts to result in change to flooding from rivers — catchment properties, such as geology, land cover, land management; as well as changes to urban extent, floodplain occupation and the value of property at risk.
Inertia: Short-term	
Confidence: High	

Adaptation actions

In the next year:	Costs
We will provide technical evidence to support the development of Government policy by Defra and the Welsh Assembly Government for climate change and Flood and Coastal Risk Management appraisal guidance	M
We will continue to seek to prevent inappropriate developments in areas at risk of flooding and future flooding, through our work under Planning Policy Statement (PPS) 25 (or equivalent) and Technical Advice Note (TAN) 15.	(L)
We will support the Department of Communities and Local Government and the Welsh Assembly Government with revision of government guidance for flood risk, climate change and spatial planning.	M
We will continue to ensure all new appraisals and scheme design and performance are tested against increased river flows to consider climate change in accordance with Government policy.	(H)

¹ High emissions risks are quoted here but this isn't what we use for risk assessment or planning purposes.

We will continue to encourage all local authorities to ensure that their plans include the recommendations from their local Catchment Flood Management Plans.	(L)
In the next 5 years:	
We will undertake research to assess the impact of climate change on reservoir safety and implement sustainable reservoir management through our leadership role.	M
We will provide technical advice to Risk Management Authorities on Government's policy through our strategic overview role.	M
We will explore the possibility of providing flood guidance to local authorities and leaving planning design to local decision.	(L)

1.3 - We will reduce the consequences of inland flooding.	
Impact	
	Rationale and uncertainty
Importance: Substantial – Severe	<p>We expect climate change to increase the frequency, extent, depth and velocity of flooding, though there will be very big differences locally. The combination of this occurring with increasing vulnerability could have serious consequences. It is imperative that we continue to advise on the location of new development to avoid the accumulation of vulnerable properties, industry and infrastructure in areas of flood risk. Our recent assessments of flood risk from rivers in England and Wales have documented that important infrastructure and public services are currently in flood risk areas:</p> <ul style="list-style-type: none"> • Water and wastewater treatment works and pumping stations are particularly at risk, since they tend to be located near rivers. We estimate that over 55 per cent of these sites in England and 80 per cent in Wales are in flood risk areas. • About 7,000 electricity infrastructure sites, some 14 per cent of all in England, are also at flood risk. In Wales, the figure is 800 sites (22 per cent). • We estimate that 10 per cent of main roads in England are at flood risk and 11 per cent in Wales. For railways the figures are 21 per cent and 33 per cent respectively. • Early indication from Environment Agency/Defra research using UKCP09 suggests that the national guidance of a 20% increase in peak flows — government's policy guidance for the design of new river plans — which was based upon UKCP02, is a pragmatic sensitivity test, but no longer precautionary for most catchments.
Proximity: Short-term	
Confidence: High	
Response (to worst case impacts)	
Resource: Major	<p>The eventual scale and spatial distribution of the climate change impacts on inland flood risk are very uncertain. There are a complex set of variables that interact to result in flooding from rivers — catchment properties, such as geology, land cover, land management; as well as changes to urban extent, floodplain occupation</p> <p>The existing building stock is replaced at a rate of less than 1% a year, and presents a significant challenge if we are to increase resilience to flooding. Action is needed to enable more flood resilient communities and infrastructure.</p>
Inertia: Short-term	
Confidence: High	
Adaptation actions	
In the next year:	Costs
We are providing guidance to help reporting authorities in their submissions to government as part of the Climate Change Act 2008. This will help some of our country's key service providers consider flood risk and climate change and their best response to those risks.	L
We will provide guidance and advice to site operators we regulate through environmental permitting to help them understand and prepare for climate change impacts on flood risk.	(L)
In the next 5 years:	
We will continue to provide guidance and advice to site operators and national infrastructure providers.	(L)
We will consider how major flood incidents may change with climate change.	M

1.4 - Our inland flood management programme provides environmental benefits.	
Impact	
	Rationale and uncertainty
Importance: Substantial	We expect climate change to have a major impact on the sustainability of water dependant habitats, although the response of these habitats is not well understood. Habitats we currently protect will also be impacted.
Proximity: Short-term	
Confidence: Medium	
Response (to worst case impacts)	
Resource: Major	Research is key to achieving this objective. Work is underway to determine the long term sustainability of wetlands under climate change.
Inertia: Short-term	
Confidence: Medium	
Adaptation actions	
In the next year:	Costs
Where cost effective, we will continue to work with natural processes to tackle flood risk, increasing the resilience of habitats to climate change including creating new wetlands and habitats that accommodate water and aid conveyance.	(H)
We will ensure that our Flood and Coastal Risk Management activities value the ecosystem benefits to the wider environment while meeting our targets and legal duties.	(H)
In the next 5 years:	
We will develop and implement a greenhouse gas reduction strategy for Flood and Coastal Risk Management activities.	M

Measures already implemented (for all Inland Flooding objectives)	Costs
We have developed catchment flood management plans for the whole of England and Wales. These help us to work with others to identify and agree policies for sustainable flood risk management for the whole catchment and for the long term (50-100 years). They consider the future impact of climate change on river flows and identify the most suitable policies for their management.	(M)
We have developed strategies for many of our main river sites looking to reduce flood risk and increase biodiversity in the long term.	(H)
We have ensured that all new appraisals and scheme design and performance are tested against increased river flows to consider climate change in accordance with Government policy.	(H)
We were consultees for regional flood risk assessments and advised on flood risk and solutions for regional and local authority plans.	(L)
We are statutory consultees on individual development plans and have sought to prevent inappropriate developments in areas at risk of flooding and future flooding.	(L)
We modelled the long-term investment needed in flood and coastal risk management over the next 25 years (2010 – 2035), taking account of the impacts of climate change (note that these figures include costs of managing risk from river and coastal flooding and erosion, but not surface water flooding). We used UKCP09 to derive the climate change factors in the long term investment plans. These reports are called <i>Future flooding in Wales: flood defences</i> and <i>Flood and coastal risk management in England – a long term investment strategy</i> .	(M)
We worked with Defra to better understand the potential changes to flood risk from climate change using new information from UKCP09. This work is on-going and will provide us with new techniques for risk assessment and an understanding of the responses required and their magnitude. The research also provided us with an understanding of how different catchment conditions affect their response to climate change. This research covers England and Wales.	M

We continue to advise our professional partners to help them understand the risks and policies in our Catchment Flood Management Plans to assist with the plans they are developing.	(L)
We have developed better indicators to monitor change in river flows, to compare predicted climate change with the trends observed by our river gauges.	M
We have researched when we might expect to see a significant change to extreme rainfall resulting from climate change. We are using this information to target our monitoring of rainfall and river flows to try to identify change as early as possible.	M
We have produced guidance in England for all organisations in England or Wales who have received a UK Government Direction or invitation to report under the Adaptation Reporting Power. This includes guidance to help them understand their risks from future inland flooding.	L

Opportunities

None identified.

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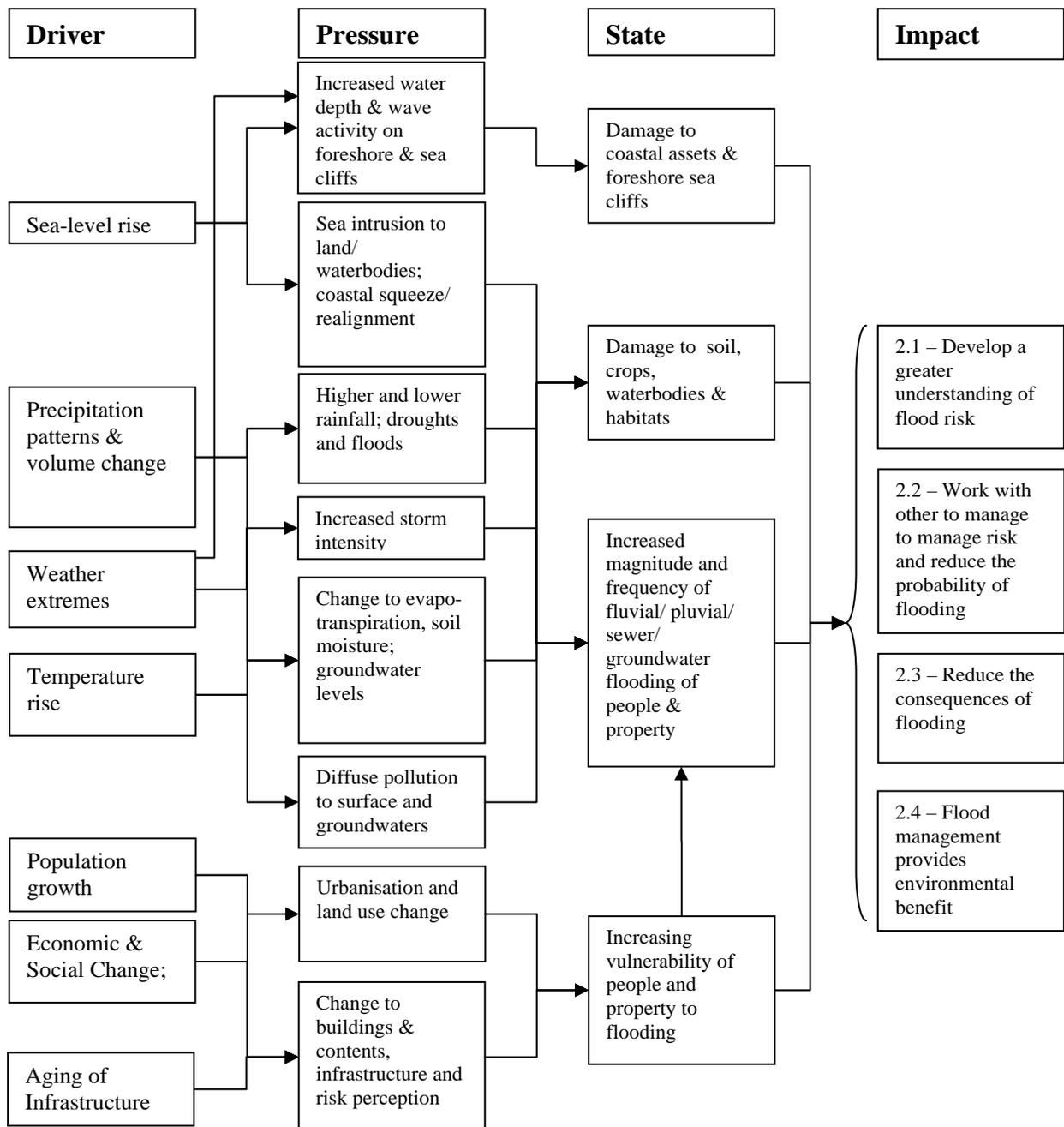
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Coastal erosion and flooding

Conceptual model of sensitive risks



Key evidence

- We have assessed potential climate change impacts on coastal erosion and flooding using UKCP09 projections, though we have not yet fully incorporated these into our flood risk models
- Our understanding of the characteristics of climate change risk, and the measures to manage risks and vulnerabilities have been developed through a number of Environment Agency Defra and Office of Science and Technology studies and are incorporated in our Long term Investment Strategy
- We have led the UK's research effort into changing time mean sea level rise and storm surges (both could greatly impact coastal flooding and erosion). This research, funded by our TE2100 project, greatly informed the first 6 chapters of the marine report in UKCP09

Risks and actions

2.1 - We, our professional partners and the public will have a greater understanding of coastal flood and erosion risk.	
Impact	
	Rationale and uncertainty
Importance: Substantial	<p>We expect climate change to significantly increase coastal flood risk to people, property and wildlife. This will challenge our ability to understand flood and coastal risks and their interactions.</p> <ul style="list-style-type: none"> • We have high confidence that increasing global temperatures will result in thermal expansion of the oceans. • We are much less confident in change from ice sheet loss and the contribution to more extreme sea level rise projections for 2100 and beyond. • There is also uncertainty in non-climate factors including property values and location of property development. • We can expect the more sea level rise, and potential increase to storminess, to bring accelerated asset deterioration and vulnerability.
Proximity: Short-term	<p>Changes in storm frequency and its contribution to flood risk over the past century have been primarily driven by natural climate variability over 10-20 year cycles. Local fluctuations in mean sea level can be of the order of 30cm. We could see 30cm rise by 2050s under UKCP09 projections. However, globally sea levels are rising now and likely to have an anthropogenic cause.</p> <ul style="list-style-type: none"> • Our assessment is very dependent on our understanding and calculation of natural variability in coastal extreme water levels and the regional oceanographic effects of UK and north east Atlantic waters.
Confidence: Medium	
Response (to worst case impacts)	
Resource: Substantial	<ul style="list-style-type: none"> • We will need to increase our efforts to deliver adaptation even though the uncertainty around climate change projections is significant. • There are physical limits to how far we can adapt and we will need to communicate the eventual risk to and potential loss of key coastal assets and land.
Inertia: Short-term	
Confidence: High	
Adaptation actions	
In the next year:	Costs
We will continue to work with others to help them understand their risks using Shoreline Management Plans to ensure co-ordination with the plans they are developing.	(L)
In the next 5 years:	
We will revisit our strategic plans where suggested by the climate change evidence and Government policy.	(L)
We will provide technical advice to our partners on representing climate change in their risk assessments.	(L)
We will provide technical advice to Defra, the Welsh Assembly Government and Lead Local Flood Authorities to enable climate change to be integral to achievement of Flood Risk Regulations (2009).	(L)
We are developing a coastal research strategy, part of the wide range of research and development we undertake to increase our understanding of coastal change and management.	M
We will further develop methods to ensure climate change is fully considered in flood and erosion estimation of current/ baseline conditions.	M

2.2 - We will work effectively with our professional partners and the public to manage risk and reduce the probability of coastal flooding and erosion.	
Impact	
Importance: Substantial – Severe	Rationale and uncertainty The latest UK Climate Projections (UKCP09) suggest that sea levels could rise by between 12cm and 76cm by 2095 around the UK with most of this rise attributed to thermal expansion of the oceans. A worst case projection which attributes more influence from glacial ice melt was also derived and is estimated at 1.9m at its highest. Changes in land use, and the location of larger populations and key services to coastal areas have both increased vulnerability, which is equally important in the calculation of flood risk. <ul style="list-style-type: none">• England has approximately 4,500km of coastline, of which 60 per cent is at risk of flooding and 40 per cent at risk of erosion• Wales has approximately 1,500km of coastline, of which 51 per cent is at risk of flooding and 49 per cent at risk from erosion• Across England and Wales, 91 per cent of the coastline at risk of flooding has flood (sea) defences that reduce the frequency of flooding (mostly protecting land against a 1 in 200 year event)• Most of the undefended flood plain is made up of saltmarsh or other land that benefits from flooding and also provides a buffer for coastal processes. No fully integrated assessment has been undertaken of the potential flood losses arising from the UKCP09 projections. However, there are a number of previous assessments that indicate the scale of the change. The Association of British Insurers estimated that a 0.4m sea level rise would increase the number of properties at risk in eastern England from 270,000 to 404,000. We should expect severe public scrutiny and challenge if we did not plan adequately for flood and coastal erosion risk over the long term. <ul style="list-style-type: none">• Sea levels are rising globally and no matter what greenhouse gas emission cuts are made some changes are inevitable and very long lived.• We can expect sea levels around the UK to rise, raising extreme coastal water levels too. We can expect these changes to continue for centuries to come. Decisions we make now must factor that in if we are to provide sustainable flood management solutions.
Proximity: Now	
Confidence: High	
Response (to worst case impacts)	
Resource: Major	This is the major focus of our flooding and coastal erosion adaptation work. Whether providing new flood management assets, developing our modelling and mapping or through our leadership, we are putting climate change at the heart of what we do. <ul style="list-style-type: none">• The eventual scale and extent of coastal flood risk is very uncertain. Equally, the impact of climate change on coastal erosion is strongly correlated to local conditions and drivers such as land use change and coastal management. There are a complex set of variables that interact to result in change to coastal erosion. The magnitude of damage from coastal flooding will be the result of floodplain occupation, the value of property at risk and the resources available to respond. There are also physical limits to how far we can adapt while retaining the existing coast line.
Inertia: Short-term	
Confidence: High	
Adaptation actions	
In the next year:	Costs
We provide technical evidence to support the development of Government policy by Defra and the Welsh Assembly Government for climate change and Flood and Coastal Risk Management appraisal guidance.	M
We will continue to seek to prevent inappropriate developments in areas at risk of coastal flooding and future flooding, through our work under Planning Policy Statement (PPS) 25 (or equivalent) and Technical Advice Note (TAN) 15.	(L)
We will support Department of Communities and Local Government and the Welsh Assembly Government with revision of Government guidance for flood risk, climate	M

change and spatial planning.	
We will continue to ensure all new strategies and scheme design and performance are tested against increased sea levels to allow for climate change in accordance with Government policy.	(H)
We will continue to encourage others to ensure that their plans include the recommendations from their local Shoreline Management Plans.	(L)
In the next 5 years:	
We will provide technical advice to Risk Management Authorities on Government's policy through our strategic overview role.	M
We will explore the possibility of increased localism by providing flood guidance to local authorities and leaving planning design to local decision.	(L)

2.3 - We will reduce the consequences of coastal flooding and erosion.

Impact

	Rationale and uncertainty
Importance: Substantial – Severe	We expect climate change to increase the frequency, extent, depth and velocity of coastal flooding. We expect changes to cliff recession rates, and loss of foreshore material, but changes will be highly influenced by local conditions. The coastal floodplains of the south-east and east coast would experience the greatest increase in probability of flooding under current projections of sea level rise. Other areas, such as north Norfolk, south Wales and along the outer Humber Estuary, also exhibit significant increases. We can expect there to be increasing flood and erosion risk from rising sea levels and potentially at an accelerating rate through the century.
Proximity: Possibly short-term	
Confidence: Medium	

Response (to worst case impacts)

Resource: Major	The eventual scale of the climate change impacts on sea level rise are very uncertain. <ul style="list-style-type: none"> Non-climate risk factors including property values and location of property development are highly influenced by regulation both at national and local scales. The influence of these drivers could have significant consequences for future economic losses and our ability to adapt.. Action is needed to make communities and infrastructure that could be vulnerable to future coastal flooding more resilient.
Inertia: Short-term	
Confidence: High	

Adaptation actions

In the next year:	Costs
We are providing guidance and support to help reporting authorities in their submissions to government as part of the Climate Change Act 2008. This will help some of our country's key service providers consider flood and coastal erosion risk and climate change and their best response to those risks.	L
We will provide guidance and advice to site operators we regulate through environmental permitting to help them understand and prepare for climate change impacts on coastal flood risk.	(L)
In the next 5 years:	
We will continue to provide guidance and advice to site operators and national infrastructure providers.	(L)

2.4 - Our coastal flood and erosion management programme provides environmental benefits.

Impact

	Rationale and uncertainty
Importance: Substantial	We expect climate change to have a major impact on the sustainability of intertidal habitats and protected habitats behind sea defences, especially freshwater habitats. The response of these habitats is well known. Habitats we currently

Proximity: Now	protect will be impacted.
Confidence: Medium	<ul style="list-style-type: none"> We have high confidence that increasing temperatures will result in increasing winter rainfall totals and intensity leading to increased cliff failure. Increased temperatures will also impact habitat health, as well as changes to salinity, rainfall, and river flow regimes. There is evidence that historic sea level rise has already impacted inter-tidal habitat health.

Response (to worst case impacts)

Resource: Major	<p>We deliver habitat management both through our estuary plans as well as for local schemes.</p> <ul style="list-style-type: none"> Where a sea wall shares a boundary with Special Protection Areas/Special Areas of Conservation, the Environment Agency/Local Planning Authority must consider whether a project to maintain or improve it in the face of sea level rise is likely to have a significant effect on the site. Defra encourages us to adopt a strategic approach to intertidal habitat re-creation and to compensate for sea level rise on an estuary wide basis to help avoid scheme delays. We use existing strategic planning approaches (such as Shoreline Management Plans and estuary strategies) to help anticipate habitat creation requirements and opportunities. Research is key to achieving this objective. Work is underway to determine the long term sustainability of wetlands under climate change as well as salt marsh condition and extent. There are coastal monitoring programmes we contribute too, as well as local biodiversity action plans.
Inertia: Short-term	
Confidence: Medium	

Adaptation actions

In the next year:	Costs
We will continue to create new wetlands and inter-tidal habitats that accommodate estuarine and coastal water where legally required.	(H)
We will ensure that Flood and Coastal Risk Management activities value the ecosystem benefits to the wider environment while meeting our targets and legal duties.	(H)
In the next 5 years:	
We will develop and implement a greenhouse gas reduction strategy for all Flood and Coastal Risk Management activities.	M

Measures already implemented (for all Coastal Erosion and Flooding objectives)	Costs
We have worked to support the development of 22 Shoreline Management Plans for the whole of the coast of England and Wales. They contain flood and coastal erosion risk management policies for 20, 50 and 100 years into the future. Currently, local authorities are revising 18 Shoreline Management Plans and the Environment Agency the remaining four; 20 will be complete by end 2010, the remaining 2, in Wales, will be completed by spring/summer 2011.	(M)
To support the shoreline management plans we have developed coastal erosion information to help all understand the risks we face. These include an assessment of the impact of rising sea levels and winter rainfall using UKCP09 projections.	(H)
We have developed strategies for many of our estuaries looking to reduce flood risk and increase biodiversity in the long term.	(H)
We have ensured that all new appraisals and scheme design and performance allow for increased sea levels from climate change in accordance with Government policy.	(H)
In England we are statutory consultees for regional flood risk assessments and advise on flood risk and solutions for regional and local authority plans.	(L)
We are statutory consultees on individual development plans and seek to prevent inappropriate developments in areas at risk of flooding and future flooding.	(L)
We modelled the long-term investment needed in flood and coastal risk management over the next 25 years (2010 – 2035), taking account of the impacts of climate change (note	(M)

that these figures include costs of managing risk from river and coastal flooding and erosion, but not surface water flooding). We used UKCP09 to derive the climate change factors in the long term investment plans. These reports are called <i>Future flooding in Wales: flood defences</i> and <i>Flood and coastal risk management in England – a long term investment strategy</i> .	
We have produced a long term flood risk management plan for London and the Thames Estuary through the Thames Estuary 2100 project. This plan has developed a flexible approach to adaptation and has been identified as best practice internationally. It is being used in other coastal cities such as Rotterdam	(H)
In England we worked in partnership with Defra and the Department of Communities and Local Government (CLG), to develop a toolkit that considers financial aid, planning choices, community self-help and social justice issues. All of these are important in encouraging and supporting people severely affected by coastal flooding or erosion to either move or accept the threat of increased risk.	(L)
We also advise and provide evidence to Governments on flood risk issues and on flood-related, coastal erosion and climate change adaptation helping them to develop policy.	N/A
In England we are working to develop inter-tidal habitats, and aim to create 200 hectares of protected habitat – half of which should be salt-marsh – each year. We have spent more than £3 million supporting saltmarsh and mudflat creation partnership projects over the past five years.	(H)
We encourage others to ensure that their plans include the recommendations from their local Shoreline Management Plans.	(L)
We have produced guidance in England for all organisations in England or Wales who have received a UK Government Direction or invitation to report under the Adaptation Reporting Power. This includes guidance to help them understand their risks from future coastal flooding and/or erosion.	L

Opportunities

None identified.

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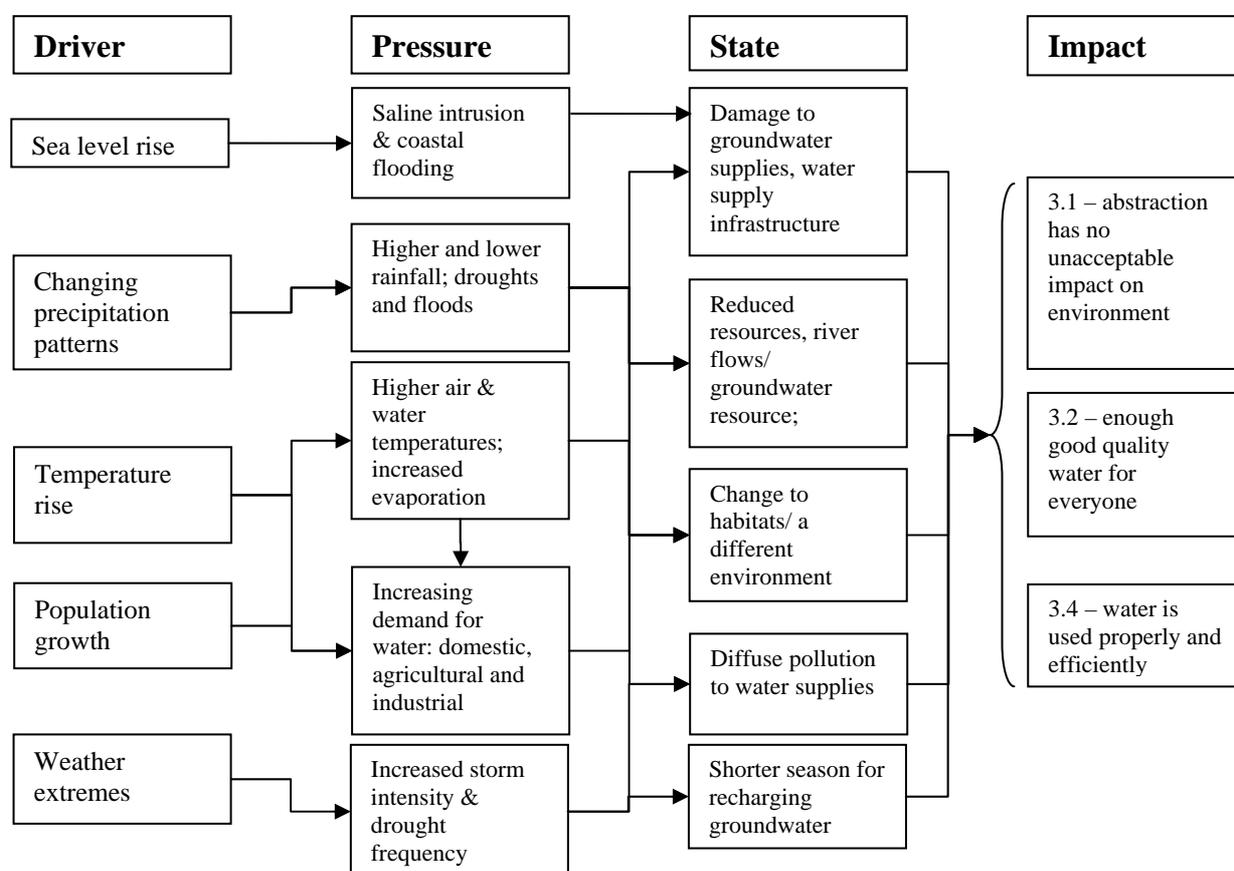
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Water resources

Conceptual model of sensitive risks



Key evidence

- We have modelled the potential climate change impacts on river flows in England and Wales by 2050, using UKCIP02 scenarios. These are currently being updated using UKCP09
- We have forecast the effects of non-climate drivers on water resources and potential increases in water demand by the 2050s. These are incorporated in our Water Resources Strategy 2009
- We have undertaken our own research to understand when climate change may noticeably alter precipitation patterns and extremes. This is published in peer reviewed academic literature
- We rely on external research to help us better understand changes to extreme rainfall, which at present is not well represented in climate models, UKCP09 being an example

Risks and actions

3.1 - We will aim to ensure that abstraction has no unacceptable impact on the environment or water users.

Impact

Rationale and uncertainty

Importance: Substantial – Severe	<p>Our existing suite of water resource management measures will not be sufficient to manage the worst impacts of climate change. We may begin to attribute changes in extreme rainfall amounts to climate change within the next 15 years. It is possible however that the normal year to year variations in weather may mask shifts in climate over the next 20 to 30 years.</p> <p>Therefore we expect that the existing ways to regulate abstraction and manage drought should be able to cope with the impacts we expect to occur over the next 20 years. However, we will need to identify and evaluate options for the future management of water now so that we can respond more flexibly to future pressures. We have not yet fully assessed the importance of projected impacts on our objectives.</p>	
Proximity: Short-term	<ul style="list-style-type: none"> We assume an 18 per cent increase in population from 2006 levels by 2030. The population in some parts of the country is expected to increase by over 40 per cent. This will generate significant additional demand on water resources for domestic consumption, but also for the water used to produce food, energy and products. Additional demands and pressures on water resources may be felt more in areas where pressures already exist such as south east and eastern England. In East Anglia in particular, projected impacts from higher evaporation and reduced summer rainfall could have a major impact on agriculture and the demand for water to irrigate crops. 	
Confidence: Medium	<ul style="list-style-type: none"> In other parts of England and in Wales where the underlying rocks are of low permeability, the lack of natural water storage will mean that expected reductions in summer river flows will be more pronounced. Although we have identified the potential impact from sea-level rise and associated saline intrusion to groundwater resources, our initial assessment suggests that this is not a significant threat based on existing projections. This is due to the effective management by water companies of groundwater resources near the coast. 	
Response (to worst case impacts)		
Resource: Substantial	<ul style="list-style-type: none"> The existing actions within the Water Resources Strategy can provide a range of response options to cope with many possible short to medium term impacts. We need to undertake further studies to understand how robust our existing response options are to climate change. 	
Inertia: Short - Medium term		
Confidence: Medium		
Adaptation actions		
In the next year:		Costs
(1) We will work with Defra, the Welsh Assembly Government and Ofwat to develop and evaluate options for future access to and allocation of water.		M
(2) We will advise Government on water supply resilience, and in particular identify areas for improvement in supply connectivity and integration.		L
(3) We will continue to promote joint guidance on the construction and development of small scale storage reservoirs and water efficiency.		L
(4) We will develop our evidence base on the understanding of ecological responses to abstraction and related pressures. We will apply this understanding to climate change scenarios to inform our future approach and direction.		M
(5) We will seek opportunities to understand how greenhouse gas emissions are generated in other sectors of abstraction and wastewater collection and treatment. We will look to gather baseline energy/water-use data across other sectors (agriculture, industry and power generation), with a view to providing advice to Government and assessing options to reduce energy consumption relating to those abstraction and wastewater activities.		L
(6) We will develop an evidence-based, coordinated approach to climate change adaptation and mitigation for key types of abstraction, and wastewater treatment. We propose to develop information on adaptive management for water resources infrastructure and water resources management		M

(7) We will minimise emissions associated with our own and others' water related activities and deliver against the CRC Energy Efficiency Scheme, with a particular focus on how water resource schemes are operated and managed.	M
(8) We will review our advice on heat pumps and hydropower to ensure that we are actively supporting the UK and Welsh Assembly Governments' carbon reduction and energy production agendas, while maintaining environmental protection.	L
(9) We will develop a good understanding of the links between levels of service and deployable output for public water supply. We will update the Water Resources Planning Guidelines and Drought Planning Guidelines.	M
(10) We will identify actions to increase the resilience of water supplies that underpin food and energy security. We will work with Defra and the Welsh Assembly Government to develop a greater understanding of the potential impact from climate change on embedded water demands in goods and products, and any risks to water resources in England and Wales. We will collect and assess evidence on embedded water to enable us to provide advice.	M
(11) We will work with the Energy Savings Trust to advise the Welsh Assembly Government and others to ensure that water and energy efficiency are considered together in future retrofit programmes such as the Home Energy Efficiency Scheme and the Welsh Housing Quality Standard.	L
In the next 5 years:	
We expect components of the following measures to be carried out over the next 5 years: 2, 3, 4, 5, 6, 7, 9. For Wales we expect relevant linked actions to be carried out over the next 5 years including 11.	
We will factor the impacts of climate change, based on UKCP09 projections, into all of our work, but in particular in water resource planning and flood risk management. We will produce an 'archive' of future flows to the 2050s, using UKCP09, to ensure consistent application in impacts assessments by us and our partners	
We will work with water companies and others to avoid future water shortages.	
We will advise large water users, for example industry, agriculture and the energy sector, on ways to reduce water use and cut costs.	
We will advise Local Planning Authorities and developers on the availability of non-mains water supplies and water efficiency.	
We will carry out research and work with others to understand sector vulnerability (energy, agriculture, industry) and sector specific adaptation, minimising risks and ensuring efficiency. We will provide advice to Government to enable them to take a strategic overview.	
We will work to further understand the benefits of retrofitting, where practicable, Sustainable Drainage Systems (SuDS) to existing sewerage systems	
Specifically in Wales, we will advise and provide evidence to the Welsh Assembly Government, Ofwat, Dwr Cymru (Welsh Water) and relevant parties on how to improve water efficiency across all sectors.	
Longer term actions:	
We expect components of the following actions to be carried out over the longer term: <ul style="list-style-type: none"> • We will advise Government on water supply resilience, and in particular identify areas for improvement in supply connectivity and integration. • We will develop our evidence base on the understanding of ecological responses to abstraction and related pressures. We will apply this understanding to climate change scenarios to inform our future approach and direction. 	

3.2 - We will aim to ensure that there is enough good quality water for people, businesses, industry and agriculture most of the time.

Impact

	Rationale and uncertainty
Importance: Substantial	We have developed a catchment-level model of the impacts of climate change on river flows, and used this to understand the impacts on our objectives. This model (which used UKCIP02 scenarios) suggests that by 2050, natural river flows in winter may increase by 10 to 15 per cent but with lower flows in most rivers from

Proximity: Short - Medium term	April to December. Natural river flows in the late summer and early autumn could fall by over 50 per cent, and by as much as 80 per cent in some catchments. Overall, this could mean a drop in natural annual river flows of up to 15 per cent. Changes in the amount of reliable rainfall will affect the yields of existing supplies, and the economics of future options. Droughts could be more frequent, affecting supplies for people, business, industry and agriculture.
Confidence: Medium	<ul style="list-style-type: none"> We will need to identify and evaluate options for the future management of water now so that we can respond more flexibly to future pressures. We have not completed our investigation on how our decision making processes for water allocation will be affected by climate change.
Response (to worst case impacts)	
Resource: Substantial	The resource required to make changes to decision making processes and prioritisation is uncertain but it could take a significant amount of time to support regulatory change, support the development of new legislation and to develop and implement new procedures.
Inertia: Short - Medium term	
Confidence: Medium	
Adaptation actions	
As for 3.1 above	

3.3 - We will publish information on the demand for water and available resources.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect our ability to publish information on the demand for water and available resources. However we can use this objective to influence and encourage adaptation in the actions of others.
Adaptation actions	
In the next year:	Costs
We will carry out routine work and specific projects which contribute to climate change adaptation, such as the annual review of our drought plans to ensure they are fit for purpose and take account of climate change, reviewing water resource management plans and providing technical advice to Government.	L
We will identify effective methods of communicating with the different types of abstractors to ensure they are aware of the impacts of climate change.	L
We will monitor the effects of climate change and will continue to review our monitoring networks to ensure that they are fit for their intended purpose.	L
In the next 5 years:	
We will update guidance to water companies on developing statutory water resources management plans and drought plans to reflect the pressures from climate change.	M
We will work with others to assess how climate change will impact on the frequency and intensity of drought.	M
Longer term actions:	
We will continue to promote efficient water use and adoption of supply options that will be resilient to the impacts of climate change with water companies and other abstractors through our water resource strategy.	M

3.4 - We will aim to ensure that water is used properly and efficiently.	
Impact	
	Rationale and uncertainty
Importance: Substantial – Severe	Our concerns focus on water resources planning and water security in the context of greater demand and reduced availability. The risk of drought is also of major importance for the Environment Agency in terms of the implications for the

Proximity: Short – Medium term	environment and our duty to protect and enhance ecosystems and biodiversity, and also in terms of compliance with EU legislation such as the Habitats Directive. The combined pressures of lower water availability and increased water demand will present a big challenge to meet this objective.
Confidence: Medium – High	
Response (to worst case impacts)	
Resource: Moderate	Changes to decision making processes and prioritisation will probably not require excessive resources but it could take a significant amount of time to support regulatory change, support the development of new legislation and to develop and implement new procedures. Policy responses to climate change may impact on water resources. For example, the planting of perennial energy crops such as Miscanthus and short rotation coppice can reduce recharge to groundwater considerably.
Inertia: Short – Medium term	
Confidence: Medium	
Adaptation actions	
As for 3.1 above	

Measures already implemented (for all Water Resources objectives)	Costs
We have carried out initial research and worked with others to assess how climate change will affect water resources including impacts on: <ul style="list-style-type: none"> - river flows and groundwater levels; - water demand. This work provided evidence to support our water resources strategy published in 2009.	M
We published our Water Resources Strategy for England and Wales, and a separate strategy for Wales in 2009. They included evidence of expected climate change impacts and set out actions for managing water resources to adapt to climate change. We now have regional and national plans for progressing these adaptation actions.	M
We have reviewed all water company drought plans and have provided advice to the Secretary of State / Welsh Ministers. We have also reviewed and updated our own drought plans.	M
We have reviewed all draft water company water resources management plans including providing advice to the Secretary of State / Welsh Ministers, and have provided evidence to public inquiries on two company plans.	M
We have developed Catchment Abstraction Management Strategies (CAMS) and River Basin Management Plans for England and Wales. We will use them to assess the sustainability of abstraction of water. This will be used as an indicator to provide a measure of Government progress on adaptation to climate change.	H
We include time limits on all new abstraction licences (by law) and have a policy of applying time limits to varied abstraction licences. We are working with the UK Government and the Welsh Assembly Government to identify and assess future models for water management, which will include consideration of the flexibility required for the future.	M
We are encouraging abstractors and water users to adopt cost effective demand management measures by providing advice and active promotion.	M
We have advised the Welsh Assembly Government on adaptation and water resources through the Climate Change Commission for Wales and the forthcoming Climate Change Strategy for Wales.	L
We are carrying out work to review our hydrometric and groundwater monitoring networks to ensure they are fit for purpose for detecting climate change impacts.	M
We will advise the Welsh Assembly Government on the implications of ‘embedded water’ in support of the development of a new Food Strategy for Wales.	L

Opportunities

- A warmer climate may provide opportunities for growing different crops and increasing crop yields (possibly however at the cost of greater water demand for crop irrigation).
- Climate change is likely to drive incentives for investment and innovation in low carbon technology and in developments to improve water efficiency.
- There will be opportunities for working in partnership with the UK and the Welsh Assembly Government, statutory bodies and groups representing water users to pool knowledge and develop a co-ordinated approach to climate change adaptation.

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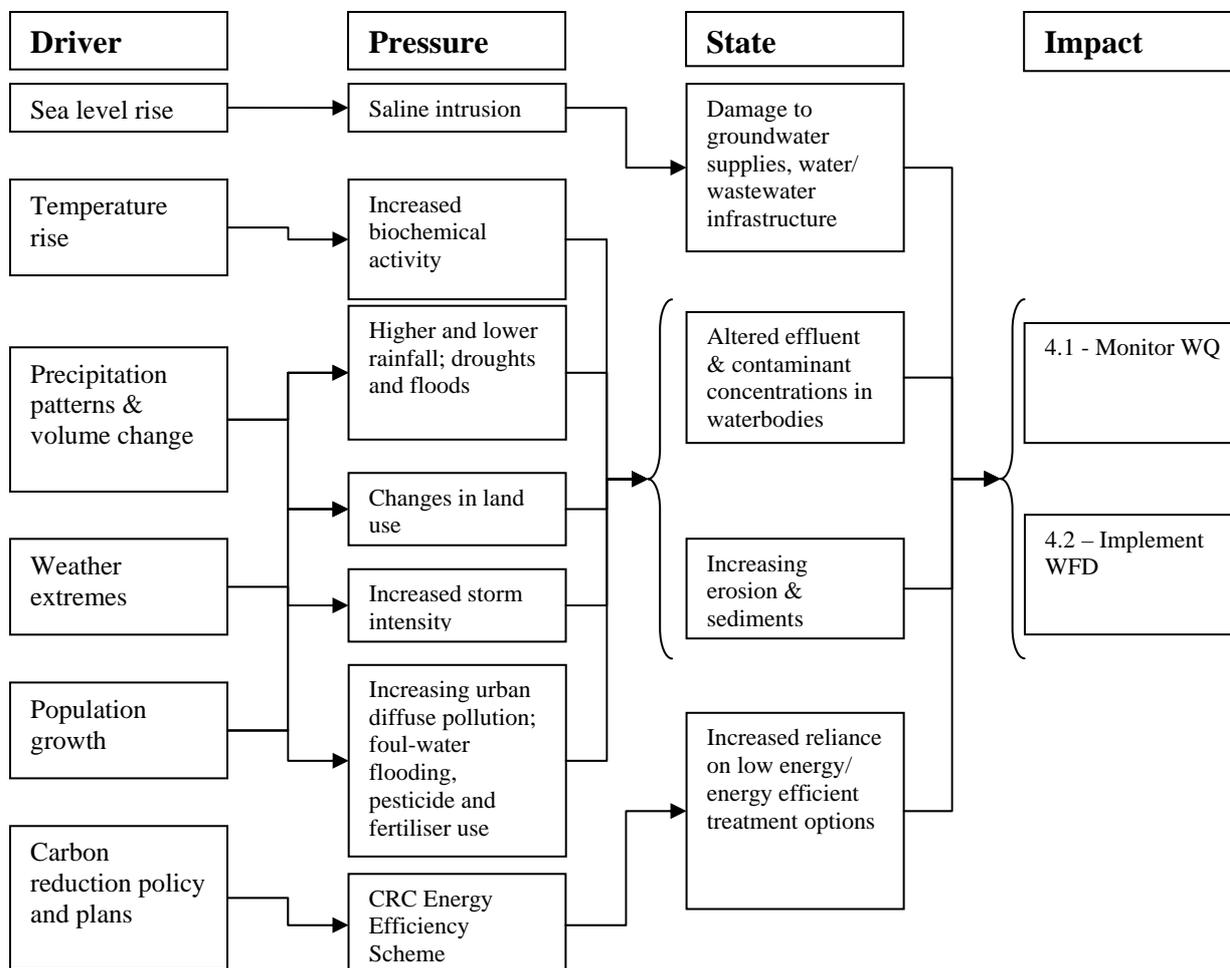
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Water quality

Conceptual model of sensitive risks



Key evidence
- We have modelled the potential climate change impacts on river flows in England and Wales by 2050, using UKCIP02 scenarios. These are currently being updated using UKCP09
- We model the impacts of climate change on water quality and WFD objectives using our SIMCAT model and the outputs of our 2050s river flows model.
- We have also assessed climate change impacts on water quality using The University of Reading's INCA model. We have also completed a review of the available academic literature.

Risks and actions

4.1 - We will monitor sewage treatment works and trade discharges, as well as the quality of freshwater, groundwater and tidal waters (up to three miles from the coast).	
Impact	
	Rationale and uncertainty
Importance: Minor	Our monitoring approach should be able to accommodate changing pollutant pressures and will not need to significantly change in the near future as a result of climate change. Our evidence is based on consultation with sampling teams to understand how we accommodate different types of weather conditions and a

Proximity: Short – Medium term	<p>qualitative assessment of how climate change will affect this.</p> <ul style="list-style-type: none"> We are unlikely to require a change in approach to monitoring in the short term. However, due to our yearly revision, monitoring may be adjusted in order to best allow detection of climate change impacts on the water environment.
Confidence: Medium	<ul style="list-style-type: none"> There may be changes in legislation which mean that our monitoring programme might need to change significantly, and thus the sensitivity to climate change may differ from that assessed for our current approach.
Response (to worst case impacts)	
Resource: Minor	Adjustments to monitoring will be required (for example how to deal with missing samples due to extreme weather events) but should not negatively affect the wider organisation. For example, an increased need for monitoring would require funding but could also benefit work to assess water quality compliance and impacts.
Inertia: Short - Medium term	
Confidence: Medium	
Adaptation actions	
In the next year:	Costs
We will work with internal partners to ensure consistent aims and objectives for future water quality monitoring requirements.	L
In the next 5 years:	
We will continue to use monitoring results to assess changes in the water environment, always using the most recent figures for river flows and rainfall when modelling for climate change.	L

4.2 - We will implement the EC Water Framework Directive and other EC directives; to ensure that all relevant water quality standards are met.	
Impact	
	Rationale and uncertainty
Importance: Substantial	<p>Our understanding of the effects of climate change on surface water quality is primarily based on mathematical (SIMCAT) modelling of climate change-driven changes (using UKCIP02 scenarios) in river and wastewater flows and temperature. This model is concerned primarily with the effects from point source discharges and their interaction with waterbodies. We have used it to estimate potential changes in water quality in terms of Water Framework Directive (WFD) definitions. Our models suggest that by the 2050s, a relatively small deterioration in quality will have occurred – approx 0.80 per cent of rivers are lost from High Status and 0.68 per cent enter Bad Status – assuming population and other factors remain constant. Our ability to achieve Good Status and Protected Area Objectives (for example for bathing, shellfish and drinking waters) is unlikely to be significantly impacted by climate change within the first three cycles of the WFD (up to 2027) since climate impacts are unlikely to be identifiable at a range beyond natural variability. However, other impacts resulting from initiatives to mitigate or adapt to climate change, such as land management change may have a positive or negative impact on surface and groundwater quality in the shorter term and we</p>

<p>Proximity: Medium term</p>	<p>will have to be responsive to significant changes. For groundwater, we set threshold values which may need to be revisited and reassessed as part of River Basin Management Planning.</p> <p>In theory the cyclical approach of river basin management under the WFD (and EC Directives on urban wastewater treatment, bathing waters, shellfish waters, freshwater fish and nitrates) should be robust to deal with most climate change impacts and if necessary can be refined. However our ability to maintain Good Ecological and Chemical Status, Good Groundwater Status and achieve Protected Area Objectives, could be substantially compromised in the latter half of the century at the higher end of projections of change (for example, effects from storms and reductions in river flows and groundwater recharge).</p>
<p>Confidence: Medium</p>	<ul style="list-style-type: none"> • We assume that initiatives to reduce carbon emissions do not significantly impact on the level of treatment of wastewater. Operators are likely to need to be more innovative. • The approach to River Basin Management under the WFD is applied across all EU Member States; therefore we assume that it already works across a range of climates. • Our evidence is based on a few studies and our modelling, but more information is required to understand the impacts from other drivers, for example diffuse pollution pressures. • Due to natural variability and variation in factors controlling water quality there are difficulties in attributing any present change to climate change. However, river water temperature has changed already and is expected to continue to rise, and this will impact on water quality. • We currently see some of the biggest groundwater quality problems in areas of intensive agriculture where rainfall is relatively low. With climate change, these problems could get worse. • Our SIMCAT modelling relies on a number of assumptions regarding the influence of diffuse pollution, and the dynamics and characteristics of a range of WFD regulated substances in the environment.
<p>Response (to worst case impacts)</p>	
<p>Resource: Moderate</p>	<p>Revision of the WFD and related directives' standards and conditions should be relatively easy to implement, and we would expect direction from the EU in the event, to adjust those standards and conditions. For groundwater threshold values that we derive, we are able to refine these as new information becomes available.</p>
<p>Inertia: Short-term</p>	<p>We are now expected by EU Water Directors to monitor our water bodies in a way that will observe climate change impacts on the water environment and allow us to adapt accordingly.</p>
<p>Confidence: Medium</p>	<ul style="list-style-type: none"> • We continue to review consents in light of changes to river temperature and flow assessed through Water Quality modelling. Our planning processes already provide the opportunity to review water quality and pressures upon it, for example through River Basin Management Planning and the water industry periodic review process. • Changes to a water's typology or designation could mean increased investment is needed to maintain the required environmental standards. Therefore it will remain important that we keep the applicability of our approach to modelling under review. • Resultant changes in ecological assemblages could require us to re-assess protection objectives taking a more strategic view on future investment.
<p>Adaptation actions</p>	
<p>In the next year:</p>	<p>Costs</p>
<p>We are planning to consult on the introduction of a consistent approach to setting numeric permit limits. For example benefits could be gained by reviewing permit conditions using improved estimates of discharge, river flow and water quality, and the correlation between these.</p>	<p>L</p>
<p>We will review risks in light of UKCP09. We will consider the impacts and costs across a range of probabilities of climate change projections, including the extremes. We will update our projections for the 2050s. This work is ongoing using flow duration curves provided by</p>	<p>L</p>

HR Wallingford and will support the national Climate Change Risk Assessment.	
Following the work above to review risks in light of UKCP09, we will assess the need for research on changes in the joint probability of intense rainfall during or after a long period of low river flow.	L
We will help to ensure that the carbon consequences of proposed EU water quality policy are considered.	L
In the next 5 years:	
We will continue to identify the benefits to surface and groundwater quality from action on the demand for water, the management of the risks of floods, the use of land, and the objectives for conservation.	L
We will work to understand if we can use UKCP09 projections to better understand climate change impacts on groundwater quality.	L
Longer term actions:	
We will consider possible direct climate change impacts (and secondary impacts) when developing methods for future cycles of River Basin Planning.	
Working with partners we will continue to develop water quality modelling capability to improve the assessment of the potential impacts of changing pressures.	
We will continue to identify the benefits to surface and groundwater quality from action on the demand for water, the management of the risks of floods, the use of land, and the objectives for conservation.	
We will reflect the costs of climate change in how decisions are made. We will make sure options are assessed by Net Present Cost, with costs to perpetuity. We will continue to calculate the costs and benefits of meeting water quality standards, and to present these costs and benefits in the form required for discussions on climate change.	
We will review our policies for barriers to reducing the use of energy, in cutting the emissions of greenhouse gases, and to using less water. We will determine if and how these policies should be changed. (This is limited for now to changes that do not affect the achievement of established objectives and water quality standards, as required, for example, for the stated ambitions of Governments for the Water Framework Directive).	

Measure already implemented (for all Water Quality objectives)	Costs
We have the opportunity to review water discharge activity permits every four years (or sooner on direction of the Secretary of State), so the permitting regime is not a barrier to adapting to climate change.	(L)
Inclusion of adaptation within the last periodic review of the water industry PR09. Several companies considered adaptation in their business plans. For example, 100 catchment schemes and investigations were included in the outcome of PR09.	L
We included a climate change chapter in our first River Basin Management Plans under the Water Framework Directive.	L
Modelling using the SIMCAT water quality model and UKCIP02 derived flow factors to assess the impact of changes in river flow on water quality objectives under the Water Framework Directive.	L
We have produced a science report on <i>The potential impacts of climate change on river water quality</i> (Science Report SC070043/SR1) including a literature review, the above SIMCAT modelling, and commissioned diffuse pollution modelling from Reading University.	L

Measures which have been ruled out	Rationale
Formal alterations to our monitoring of discharges and waters based on climate change projections.	The worst case impact of climate change on our ability to monitor and the rationale for monitoring is likely to be minor.
Inclusion of climate change impacts on river flow and rainfall into the calculations used for water quality planning (beyond what we do now to use the most recent figures for past river flows and rainfall).	Modelling of impacts using UKCIP02 derived flow factors in the SIMCAT model suggest impacts of decreases in flow will be relatively minor. In addition, due to uncertainty in future flow projections, it is sensible to delay action on consent standards until changes are manifest – installation of increased wastewater treatment to deal with tighter consent standards can be relatively rapid. There would be significant financial and carbon costs with taking a precautionary approach prematurely.

Opportunities
<ul style="list-style-type: none"> • There is potential for climate change to raise the profile of the water environment and the need for sustainable water management.
<ul style="list-style-type: none"> • There are a number of opportunities relating to specific management measures driven by climate change that might support better water quality generally (for example, catchment management initiatives or better soil and nutrient management).
<ul style="list-style-type: none"> • There is an opportunity to use climate change adaptation to help integrate delivery of WFD objectives with other EU policy (for example, Common Agriculture Policy).
<ul style="list-style-type: none"> • There are opportunities to improve water quality in the environment and lower the carbon footprint of supplying good quality drinking water, for example by using catchment management approaches rather than end of pipe treatment solutions at the point of abstraction.

Key references

Common Implementation Strategy For The Water Framework Directive (2000/60/EC) Technical Report, 2009. *040 Guidance document No. 24: River Basin Management In A Changing Climate*. European Commission.

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Regulated business

Conceptual model of sensitive risks

No sensitive objectives identified

Risks and actions

Waste Management	
5.1 – We will ensure that waste is recovered or disposed of in ways which protect the environment and human health, by regulating waste management operations (including collection, transport, treatment, storage and disposal) and enforcing waste management controls in a nationally consistent manner.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of these regulatory activities. However it is important that we use this objective to encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
We will develop our understanding of the changes to waste production and the risk to waste management that may be caused by climate change. This may involve research that builds on our current understanding of increasing vulnerability, and how improved site management can help to manage risks. We also need to develop a fuller understanding of the risks that extreme weather conditions will pose, for example flooding.	L
We will examine how we record information on our compliance and incident databases to make sure that we can clearly identify any causal link between extreme weather events and permit breaches or pollution incidents.	L
We will maintain an up-to-date climate change adaptation and waste briefing pack that includes case studies, relevant outputs from research, standard presentation, good practice advice and signposts to further information.	L
We will assess the vulnerability of waste management facilities to flooding by relating the location of facilities to mapping on flood risk from river, surface water and coastal sources.	L
In the next 5 years:	
We will improve and maintain our understanding of the likely impact of climate change on landfill, including the engineering and operation of new and existing sites and the impact on closed sites.	(L)
We will consider the developing evidence base and our knowledge of risk of climate change when (i) reviewing our guidance to staff and operators; (ii) reviewing permitting, compliance assessment and monitoring procedures and standards.	(L)
Longer term actions:	
We will continue to review our existing stock of permits in the light of new and emerging evidence on climate change.	
We will continue to monitor trends in pollution events and waste arisings to ensure that we have an accurate picture of the effect of climate change on waste management.	

5.2 - We will provide comprehensive monitoring data (in conjunction with local authorities, as necessary) to enable the amount of waste arising and the final disposal method to be tracked and recorded for each significant waste stream.	
Impact	
	Rationale and uncertainty
Insensitive to climate change	Our ability to provide monitoring data, and the scope and efficacy of that monitoring regime is insensitive to climate change.
Adaptation actions	
None	

5.3 - We will assist regional bodies and local government in developing waste plans and strategies that reflect the waste hierarchy and the national waste strategy.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect delivery of this objective. However it is important that we use this objective to encourage adaptation in others.
Adaptation Actions	
In the next year:	Costs
We will investigate and seek to understand levels of awareness to the risks from climate change in both regulated industry and local authorities.	N/A
In the next 5 years:	
We will influence government, local authorities, the waste sector and waste producers to adapt their systems and processes. We will: - Build climate change adaptation into our responses to strategies, plans and proposals at the regional and local level. - Identify exemplar sectors, target effort to those least aware, and focus our work with operators who are in the most vulnerable locations. - Raise awareness of the impacts of climate change on waste and waste management and explain how others should respond.	(L)
Longer term actions:	
We will improve and maintain our understanding of the likely impact of climate change on waste arising and our waste management infrastructure.	

Regulated Industry	
5.4 - We will encourage and determine applications for new and existing installations within the timescales laid down in the Environmental Permitting Regulations.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of this objective. However it is important that we use this objective to encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
We will ensure that 10 per cent of operators have considered and made appropriate	(L)

changes, or plans, to adapt to climate change within the next year.	
For sites covered by the Control of Major Accident Hazards (COMAH) regime, we will ensure climate change adaptation plans are discussed with high risk sites.	L
In the next 5 years:	
All the sites we regulate will consider and have made appropriate changes, or plans, as part of their adaptation to climate change.	N/A

5.5 - We will set permit conditions in a consistent and proportionate fashion based on Best Available Techniques and taking into account all relevant matters including sectoral and site-specific compliance costs; and the resulting local, national and trans-boundary environmental benefits.	
5.6 - We will control industry discharges to watercourses through the powers provided by the Environmental Permitting Regulations 2010.	
5.7 - We will work with local authorities towards delivering the objectives of the National Air Quality Strategy and to support the development of regional air quality strategies.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of these regulatory activities. However it is important that we use these objectives to encourage adaptation in others.
Adaptation Actions	
In the next year:	Costs
We will consider climate change adaptation as a priority in the scheduled review of permits in the cement and lime sectors.	(L)
In the next 5 years:	
We will consider climate change adaptation as a priority in the scheduled review of waste permits.	(L)
Longer term actions:	
We will ensure that Best Available Techniques (BAT) continue to evolve taking account of merging techniques on climate change adaptation and mitigation, feeding that into ongoing permit reviews.	

Radioactive substances regulation	
5.8 - We will regulate aerial and liquid radioactive discharges, and solid radioactive waste disposal, in accordance with statutory duties, guidance and Government policy, and the security of radioactive sources used in non nuclear industry.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of this objective. However it is important that we use this objective to encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
None	-
In the next 5 years:	
In May 2011 we will receive a revised safety case for the Low Level Radioactive Waste Repository (LLWR). Climate change impacts on the evolution of the site will be important – we have required that these are addressed in the safety case and will carefully review these in the period 2011-13.	(L)

Longer term actions:
We will continue to use the most up to date evidence to ensure our regulation of radioactive substances is robust to climate change and that we effectively influence our regulatory partners.

Measures already implemented (for all Regulated Business objectives)	Costs
Waste and industry regulation	
We have prepared internal supporting guidance on ‘Pollution caused by floods at EPR activities’. The sites that we regulate have considered and made appropriate changes, or plans, to ensure resilience to both fluvial and run-off flooding.	L
Climate change adaptation has been highlighted as a priority issue in the periodic review of permits.	N/A
We use our influencing skills to raise the profile of climate change adaptation actions through other channels, such as trade association meetings.	(L)
Radioactive substances regulation	
The Health and Safety Executive (HSE) has an established lead regulatory role for nuclear sites – HSE requires them to maintain safety cases which include hazards influenced by climate change. Operators are required to review these every 10 years and must take into account updated climate change predictions when they do so. In 2009 we provided input to HSE’s draft guidance on external hazard assessment.	(L)
We regulate disposals of radioactive waste. In 2009 we updated our guidance on our regulation of disposals to account for climate change.	L
We published a revised ‘nuclear sector plan’ in 2009. This places a requirement on nuclear operators to link their safety cases and adaptation actions to the appropriate Shoreline Management Plans and Catchment Flood Management Plans.	(L)
We have developed flood risk principles for new nuclear build.	L
In 2010 we published guidance for non nuclear users of radioactive substances on the need to consider climate change driven risks, particularly flooding.	L
In 2010 we worked with the Small (non nuclear) Users’ Liaison Group to use our guidance to raise awareness of climate change driving risks and the need for users of radioactive substances to consider these.	

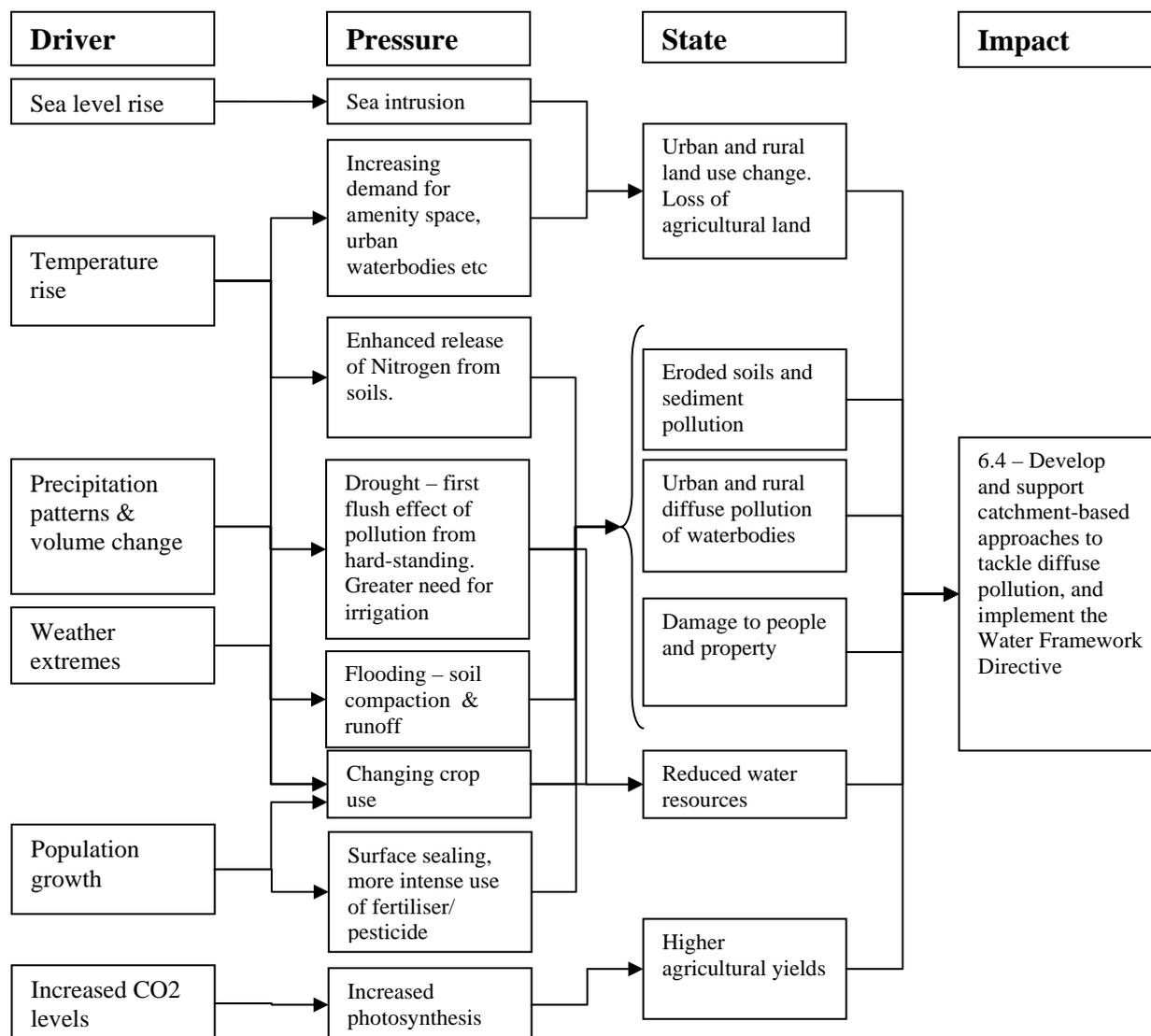
Opportunities
<ul style="list-style-type: none"> We will take the opportunity that climate change presents to increase biological treatment of waste, and harnessing the energy it produces.

Key references

UK Climate Impacts Programme, 2002. *Climate change scenarios for the United Kingdom*. UKCIP. Available online at:
http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=161&Itemid=291

Land quality

Conceptual model of sensitive risks



Key evidence

- We rely on the headline impacts provided by UKCIP02 scenarios and our understanding of the existing risks to land quality to draw conclusions about the potential risks from climate change
- We have undertaken our own research to understand when climate change may noticeably alter precipitation patterns and extremes. This is published in peer reviewed academic literature

Risks and actions

6.1 - We will act as advisors to Government on development of, or revision to, policies, strategies and legislation to ensure that they provide the right measures for effective resource protection and climate change adaptation and mitigation. For example review of the Sludge (Use in Agriculture) Regulations 1989; the Biowaste Directive; the proposed Soil Framework Directive; Contaminated Land Policy; the Rural Climate Change Forum; the review of the Common Agricultural Policy and Rural Development Plans for England

and Wales	
6.2 - We will support and contribute to the successful implementation of Government policies and strategies for example, the Defra Soil Strategy for England, the Welsh Assembly Government Environment Strategy or the sustainable use of soil policy.	
6.3 - We will carry out regulatory duties for example the Contaminated Land (England) and Contaminated Land (Wales) Regulations 2006; the Sludge (Use in Agriculture) Regulations 1989; Nitrate Pollution Prevention Regulations 2008; the Water Resources (Control of Pollution), Silage, Slurry and Agricultural Fuel Oil (England and Wales) Regulations 2010; Cross Compliance.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of these regulatory, advisory and support activities. However it is important that we use these objectives to encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
We will prioritise climate change adaptation in land quality business plans for at least the next 5 years. We will consider the suitability of existing and forthcoming measures, strategies and legislation to deliver the best outcomes for water quality, land quality and climate change (win-win, no regrets).	N/A
We will work with others to review climate projections (e.g. UKCP09 and other models) and identify future impacts on water and land. We will influence internal and external monitoring frameworks and research programmes to ensure we are able to detect signals of climate change in water and on land.	L
We will work with Defra to understand how we might use Water Protection Zones to tackle diffuse pollution and specifically the objectives of the WFD.	L
We will work with Defra and the Welsh Assembly Government to ensure that climate change adaptation is considered in developing and delivering EU and UK legislation and initiatives (for example the Common Agriculture Policy, proposed EU Soils Framework Directive; Revised Sludge Regulations; Biowaste Directive; Nitrates Directive; Catchment Sensitive Farming).	L
We will identify which organisations are best placed to help us deliver our climate change actions.	L
We will respond to the Floods and Water Bill on Sustainable Drainage Systems (SuDS); to improve our ability to develop initiatives to protect the environment against land use activities (for example agriculture and urban development) and adapt to climate change.	L
In the next 5 years:	
We will advise government on the need to build in increased winter rainfall projections into future guidance or regulation for the storage of slurry and dirty water; for example Silage, Slurry and Agricultural Fuel Oil Regulations (SSAFO).	L
We will continue to review and evaluate evidence (monitoring data, research findings) and assess how current and new measures perform in a changing climate. We will modify advice to Government accordingly for example on the proposed Biowaste Directive.	L
We will influence the revision of work programmes and processes or develop new processes to achieve the priorities of Government strategies and policies and our policies (for example, better targeting of farm inspections and more effective use of Anti-pollution Works Notices to tackle diffuse pollution).	L
Longer term actions:	
<p>We will:</p> <ul style="list-style-type: none"> - continue to assess how climate is impacting on land and water quality. - continue to review and evaluate evidence to assess how current and new measures perform in a changing climate. - continue to promote measures internally and externally, which deliver the best outcomes for land and water quality in a changing climate based on win-wins and no regrets, and implement revised 	

work programmes and processes where appropriate.

- advise government, trade organisations, other government agencies on revision to or development of new schemes/measures. (for example, the Common Agriculture Policy (CAP) and the Rural Development scheme); new approaches (for example, ecosystems services); or regulations.

6.4 - We will develop and support catchment based approaches to tackle diffuse pollution and improve water quality and other environmental objectives specified by the Water Framework Directive (that is, support the Environment Agency to fulfil our Competent Authority role for River Basin Management Planning). For example: pollution reduction programmes; Voluntary Initiative on Pesticides; the England Catchment Sensitive Farming Delivery initiative and Environment Agency Wales Catchment initiative; and the Campaign for the Farmed Environment.

Impact

Rationale and uncertainty	
Importance: Substantial	<p>This objective may be unachievable under existing regulatory and resource provisions due to potential climate change impacts. Risks to water quality increases where soil-types and land management practices are likely to cause erosion or runoff, particularly where slopes or pathways connect these areas to a watercourse. We understand individual risks and processes reasonably well but, it is not always possible to predict what the ecological impact of increased pollution will be. We would expect the greatest impacts from climate change on land quality and associated impacts on water quality to occur in agricultural areas. However some of the impacts (for example from reduced precipitation) may be positive.</p> <ul style="list-style-type: none"> • We are uncertain about the future of measures – we are unclear how some of these will perform for example in Water Protection Zones. • We are uncertain of the ecological impact from climate change relative to other pressures, for example reduced flow, habitat fragmentation, and so on. • We understand the risks and processes of erosion and run-off causing water quality failures. • Population growth is likely to lead to more urban development, particularly in the south and east, and increasing agricultural intensity in previously low or non-productive areas, such as the uplands, both of which could cause higher levels of diffuse pollution. Cultivating upland soils could exacerbate the impacts of climate change through carbon release and increased flood risk.
Proximity: Medium - Long term	
Confidence: Low	

Response (to worst case impacts)

Resource: Minor - Moderate	<p>We may require changes to land use in certain sensitive areas, rather than just changes to land management. We may need to influence how water quality improvements are assessed to reflect changes in the environmental baseline brought about by climate change, for example WFD Classification.</p> <p>We understand the nature and scale of possible responses however further scoping of options is required. Options are mainly process, regulatory and advocacy driven. We may need to change our regulatory approach where existing approaches through incentives and advice fail to effect the necessary level of change.</p> <p>Effective adaptation of land management would require a response not just from the Environment Agency but would involve local authorities, Defra, the Welsh Assembly Government, Natural England, Countryside Council of Wales and so on.</p>
Inertia: Medium - Long term	
Confidence: Medium	

Adaptation actions

In the next year:	Costs
We will assess how current and new measures (for example, for Water Protection Zones) perform.	L
In the next 5 years:	
We will influence River Basin Management to improve the appraisal process for diffuse	(L)

pollution measures so it factors in climate change aspects into measures selection (2 nd cycle RBM Plans in 2015).	
We will continue to assess how current and new measures (for example for Water Protection Zones) perform in a changing climate.	(L)
We will review data on which measures deliver the best outcomes for water quality in a changing climate, based on win-wins and no regrets.	(L)
Longer term actions:	
We will influence our water quality management within the Environment Agency to revise how water quality improvements are assessed to reflect the impacts of climate change on the environmental baseline for example, Water Framework Directive Classification.	
We will advise government on the need to change our regulatory approach where existing approaches (incentives and advice) fail to effect the necessary level of change, for example where we recommend changes to land use, rather than to land management practices.	

6.5 - We will produce, or collaborate on, climate change and resource protection guidance for urban and rural land managers. Promoting practices and incentives that encourage land managers to protect soil and water, or clean up contaminated land. For example farming for the future fact sheets; <i>thinksoils</i> ; <i>Good Farming – Better Environment</i> ; and the sustainable management of contaminated land guidance.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of this objective. However it is important that we encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
We will provide support to the Rural Climate Change Forum and ensure our existing and future policies are climate change proofed.	L
In the next 5 years:	
We will work with others to develop new guidance and tools to promote measures which deliver the best outcomes for water quality in a changing climate, based on win-wins and no regrets for example the cost effectiveness measures database.	N/A

Measures already implemented (for all Land Quality objectives)	Costs
We have agreed a common approach to adaptation with key partners, particularly with regard to modernising rural delivery and local authorities to ensure effective joint action for example, work with the Rural Climate Change Forum (RCCF).	L
We are forging stronger links with Forestry Commission and Forest Research to gain a better understanding of the role and benefits of forests in mitigation and adaptation. We are developing policies on afforestation, bioenergy and carbon sequestration.	L
In partnership with others, we have considered climate change and built in measures for water, soil, and air into the revision of CoGAP (Code of Good Agricultural Practice); Best Farming Practice guidance and the forthcoming Good Farming Better Environment report.	L
We ensure Environment Agency advice and guidance adequately considers climate change in the assessment of risk from land contamination, prioritisation of sites and receptors and the remediation methods chosen.	(L)
We use rural development funding as a platform on which to build adaptation measures in all axes. For example, we advise on the make up and targeting of agri-environment schemes in England and Wales, to encourage better farming practices which will help meet WFD priorities.	L
Our advice on the latest Nitrate Pollution Prevention Regulations 2008 helped to significantly increase the amount of on-farm slurry storage within Nitrate Vulnerable Zones, allowing for wetter winters and reducing the need for farmers to spread slurry when soil conditions are unsuitable, a major measure to reduce diffuse pollution.	(L)

We ensure that all WFD measures for agriculture are climate proof and have developed measures that will reduce the impact of intensive rainfall.	L
We have produced a paper on <i>Limiting and adapting to climate change in the uplands</i> and contributed to partnership projects, for example the Sustainable Catchment Management Programme (SCAMP) and 'Moors for the Future' to investigate how we can preserve the peat and reduce flash flooding.	L
We have helped farmers to look ahead at climate change, by helping to revise the Soil Protection Review to include measures to increase carbon storage and organic matter levels; and through our thinksoils manual and training programme (2008).	L
We have worked with Farming Futures – a partnership between key Government agencies and NGOs – to produce fact sheets for farmers on how to use water more efficiently, reduce flood risk and address some of the issues around coastal realignment.	L
Measures which have been ruled out	Rationale
Build in increased winter rainfall predictions into future guidance or regulation for the storage of slurry and dirty water. For example, Silage, Slurry and Agricultural Fuel Oil Regulations 2010 (SSAFO) to include a minimum of 6 month storage including allowance for increased precipitation.	The SSAFO Regulations were needed urgently in order to implement the Nitrate Pollution Prevention Regulations 2008; amendments would have caused too much delay. However, we still hope to bring these changes forward in the next couple of years.

Opportunities
<ul style="list-style-type: none"> • With more carbon dioxide in the atmosphere, photosynthesis and plant growth will increase. This would improve nutrient take up and utilisation, so reduce losses to water and air.
<ul style="list-style-type: none"> • In drought prone areas where lower crop yields are expected or different crops grown, less nutrients are needed, so fewer losses are expected.
<ul style="list-style-type: none"> • Higher temperatures will reduce the likelihood of frosts so there will be less frost damage to stores or pipes, containing pollutants.
<ul style="list-style-type: none"> • Revision of the Common Agricultural Policy (review in 2013) may benefit climate change adaptation objectives through facilitating changes to land management and use.

Key References

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Department of Environment Food and Rural Affairs/ Rural Payments Agency.

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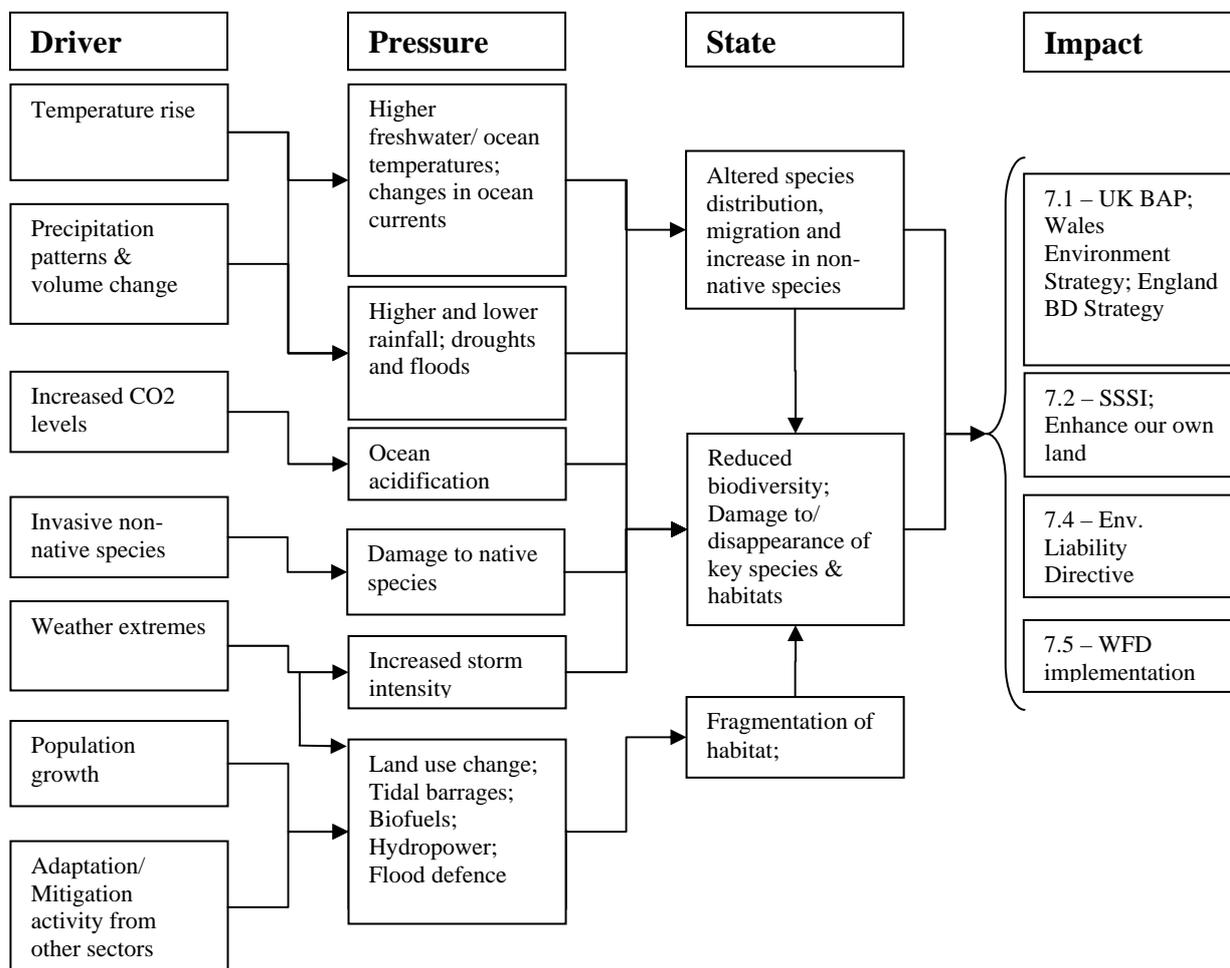
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Wildlife and habitats

Conservation and ecology

Conceptual model of sensitive risks



Key evidence
- For this assessment we rely on the headline impacts identified by UKCIP02/UKCP09, alongside academic literature, our own evidence programme and research partnerships, to understand our potential risks, the expected direction and scale of change, and how we should adapt. Much of the accumulated evidence from which we draw conclusions has relied on more detailed consideration of climate change projections.
- Our monitoring (and that of others) provides evidence of climate change already affecting wildlife, habitats and fisheries.

Risks and actions

7.1 - We will contribute to the implementation of the UK Biodiversity Action Plan, the England Biodiversity Strategy and the Wales Environment Strategy, and in particular the delivery of those actions for which the Environment Agency has lead responsibility.	
Impact	
	Rationale and uncertainty
Importance: Moderate – Substantial	Existing evidence suggests that the EU target to halt biodiversity loss by 2010 will not be met. Species extinctions are 1,000 times higher than the natural background rates, mainly due to habitat destruction, fragmentation and degradation (caused by development and intensive agriculture), as well as the impact of invasive non-native species and a lack of adequate action to deal with these pressures. Therefore our objectives are already at risk due to concurrent pressures; climate change will exacerbate these.
Proximity: Now	Predicted climate impacts would put intense direct pressure on wildlife and may cause secondary impacts such as an increased delivery of sediments to rivers, lakes and estuaries; loss of salt marshes and mudflats; and reduced dilution of pollutants during droughts. Our objectives will become increasingly difficult to achieve as a result. If we are seen to be failing our obligations for biodiversity then this is likely to have an impact on our reputation (particularly as the importance of biodiversity is rising up the political agenda). We assume that the importance of biodiversity will be increasingly recognised and that increasingly, policy decisions will take account of the value of ecosystem services. However:
Confidence: High	<ul style="list-style-type: none"> • We are uncertain about how the climate will change in the future. • While we are already failing our objectives, largely due to other pressures, the effects of climate change on ecology have already been recorded. Uncertainty is caused by the difficulty of allocating the proportion of change (for example, in abundance) to particular pressures. • We are uncertain about society’s response to future climate and the impact of that response on wildlife.
Response (to worst case impacts)	
Resource: Major	It is widely accepted that, as a society, we need to do more if we are to halt the decline of biodiversity in a changing climate. To reduce the existing pressures on wildlife and adapt to climate change, there would have to be a step change in behaviour and investment across a wide range of stakeholders.
Inertia: Rapid	We understand the nature of some of the responses required although there are many uncertainties: <ul style="list-style-type: none"> • A key assumption is that reducing existing pressures on wildlife will increase an ecosystem’s resilience to climate change.
Confidence: Medium	<ul style="list-style-type: none"> • It is assumed that we will quickly learn how to improve our approach to climate change adaptation by using ‘adaptive management’ (learning by doing). • The prediction of the impacts of climate change adaptation measures on biodiversity can only be very general due to the uncertainties involved. • It is assumed that the costs will generally be marginal as our success will depend on influencing the application of resources invested for other primary purposes. • It is assumed that there will be commitment at an EU and national level to halt the decline of biodiversity, the cost of which is high and outside the scope of this plan.
Adaptation actions	
In the next year:	Costs
We will develop and implement long-term plans to manage the landscape, to reduce temperature in rivers, lakes and estuaries and increase summer base-flows. Note that costs are high in future years but are shared across a range of stakeholders.	L

We will ensure climate change adaptation benefits are considered when prioritising fish passage projects.	L
We will promote our adaptation plan within the Environment Agency and to our partners. We will engage with the planning process to establish how we can best promote biodiversity adaptation measures, even for small scale projects.	L
We will identify those species and habitats that are most vulnerable by undertaking a vulnerability assessment. We will use the vulnerability assessment to better target existing measures. In consultation with experts, we will determine what additional action can be taken to reduce vulnerability.	L
We will commission systematic reviews to inform good operational practice within the Environment Agency. We will influence external R&D to meet our needs, track emerging literature as well as through a network of external expert contacts.	M
We will track the emerging adaptation and mitigation responses of other sectors (for example agriculture and energy) and assess the threats and opportunities for biodiversity.	L
Working with the conservation agencies and others we will review and, if necessary, revise objectives for species/habitat management to accommodate inevitable change (both positive and negative) while maximising biodiversity outcomes.	L
We will adopt adaptive management: monitor to allow us to learn from what we do. Where uncertainties are high, we will implement measures as robustly designed experiments.	L
We will work with relevant stakeholders who share our goals. We will develop shared plans for specific elements of this plan and develop suggested targets and actions that partnerships can deliver.	L
In the next 5 years:	
We will develop and implement strategic plans for relevant habitats in concert with others taking climate change into account (for example, Wetland Vision, 'Blue and Green Corridors'). We will manage the landscape and rivers to maintain and increase the generation of habitats through natural processes. We will encourage the creation of buffer zones around, rivers, lakes and coastal waters. We will make space for the natural development of rivers and coasts. Specific measures include: <ul style="list-style-type: none"> Engaging with new government tree planting scheme to target most appropriate sites and habitat types. Influencing Forestry Commission to target woodland creation schemes Promoting landscape restoration hierarchies. Ensuring our contributions to upland restoration schemes align with guidance/priorities of agencies (Natural England). Working with wetland vision to capture biodiversity adaptation benefits. 	L
Working in concert with conservation agencies, we will consider moving vulnerable species with poor dispersal capabilities particularly where suitable habitat is remote from the current location (for example, Whitefish).	L
We will ensure that training and information is provided on climate change adaptation principles and practice, adaptive management, the 'landscape scale approach', adaptation tools and no-regrets measures. For example, we are developing a tool for wetland managers that will help them factor climate change into management options	L

7.2 – We will further the conservation of Sites of Special Scientific Interest and in managing our own land, to enhance its biodiversity, cultural and recreational potential.

Impact

	Rationale and uncertainty
Importance: Moderate - Substantial	In general, climate change has not been accounted for in the objectives for Sites of Special Scientific Interest (SSSIs); they are set by the conservation agencies. A significant change in the climate would make some objectives more difficult to achieve and would require substantial investment. There are some specific examples where climate change has already had an impact on our ability to achieve objectives to the extent that we have acted (for example, 'coastal squeeze', salmon and probably eel conservation).
Proximity: Now - Short term	
Confidence: Medium - High	

Response (to worst case impacts)	
Resource: Moderate - Substantial	We are quite certain about the areas where we are already acting; however, the prediction of the impacts of climate change on biodiversity elsewhere can only be very general due to the uncertainties involved. We understand the nature of some of the types of response required although there are many uncertainties.
Inertia: Rapid - Short term	
Confidence: Low - High	
Adaptation actions	
As for 7.1 above	

7.3 - We will ensure that all Environment Agency consents where we cannot conclude no adverse effect on the integrity of a Special Protection Area, Special Area of Conservation or Ramsar site are reviewed and either affirmed, modified or revoked as appropriate, and that any new consents are dealt with in accordance with the requirements of the Conservation of Habitats and Species Regulations 2010.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of these advisory and support activities. However it is important that we use these objectives to encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
None	-
In the next 5 years:	
If and when changes in the climate lead to the need to tighten or relax a permission, we will seek to do that when a review occurs under the source legislation (that is, there is no requirement to periodically review permissions for the Habitats and Birds Directives).	M

7.4 - We will ensure that 'environmental damage' to protected species and natural habitats, and any imminent threat of such damage, in inland waters or from EA-regulated activities, is identified and addressed in accordance with the requirements of the Environmental Liability Directive.	
Impact	
	Rationale and uncertainty
Importance: Negligible	There will be virtually no impact under business as usual.
Proximity: N/A	
Confidence: Very High	
Response (to worst case impacts)	
Resource: None	There will be virtually no impact under business as usual.
Inertia: None	
Confidence: High	

Adaptation actions	
As for 7.1 above	

7.5 - We will implement the EC Water Framework Directive via the management of biological pressures, development and ownership of monitoring tools, and overseeing the design and implementation of Programmes of Measures.

Impact	
	Rationale and uncertainty
Importance: Substantial	River Basin Plans should make a significant contribution to the reduction of existing pressures on biodiversity. The delivery of these plans will become more difficult if the climate changes as predicted (for example, due to reduced flows in rivers concentrating pollutants and increased temperature reducing dissolved oxygen, ecological objectives are likely to be failed more frequently). Invasive non-native species are likely to become more invasive in a warmer climate and this will increase the risk of failure of ecological objectives. Significant resources may be required, however: <ul style="list-style-type: none"> • There is some uncertainty about how much resource will be invested in River Basin Management Plans. • There is much uncertainty about how invasive non-native species will respond to climate change. • From a WFD delivery view, climate change may not have a significant impact on ecological status as we measure it over the three cycles of WFD.
Proximity: Now - Medium term	
Confidence: Medium	

Response (to worst case impacts)	
Resource: Minor	To maximise the outcomes for biodiversity from River Basin Management Plans we need to modify these plans and their measures to maximise their benefits for climate change adaptation, while still achieving their primary objectives.
Inertia: Short-term	
Confidence: Medium to High	

Adaptation actions	
As for 7.1 above	

Measures already implemented (for all Conservation and Ecology objectives)	Costs
We have developed clear principles and guidance for climate change adaptation for biodiversity accepted across the UK Biodiversity Partnership (Defra publication).	L
Development and implementation of a single plan within the Environment Agency for climate change adaptation for biodiversity.	L
BAP habitat and 'No net loss' habitat created. 1716 ha of habitat have been created over the last 10 years.	H
Over 100 'on the ground' projects that contribute to climate change adaptation at marginal cost. (Note that there will be some overlap / double-counting with projects above).	L – M
We have developed and commissioned a range of R&D reports and publications that inform our actions by predicting the likely impacts of climate change on wildlife and wetlands, by assessing changes in water temperature and by assessing how fish and wildlife are currently responding to climate change.	M
We have decided what the priority research needs are, including how best to use and implement the new UKCP09 scenarios.	L

Opportunities

- It is likely that many of the new species that arrive as a result of climate change will be valued by people.
- Fish species that flourish in warmer climates (for example, roach, bream and carp) may increase in numbers potentially benefiting coarse fisheries.

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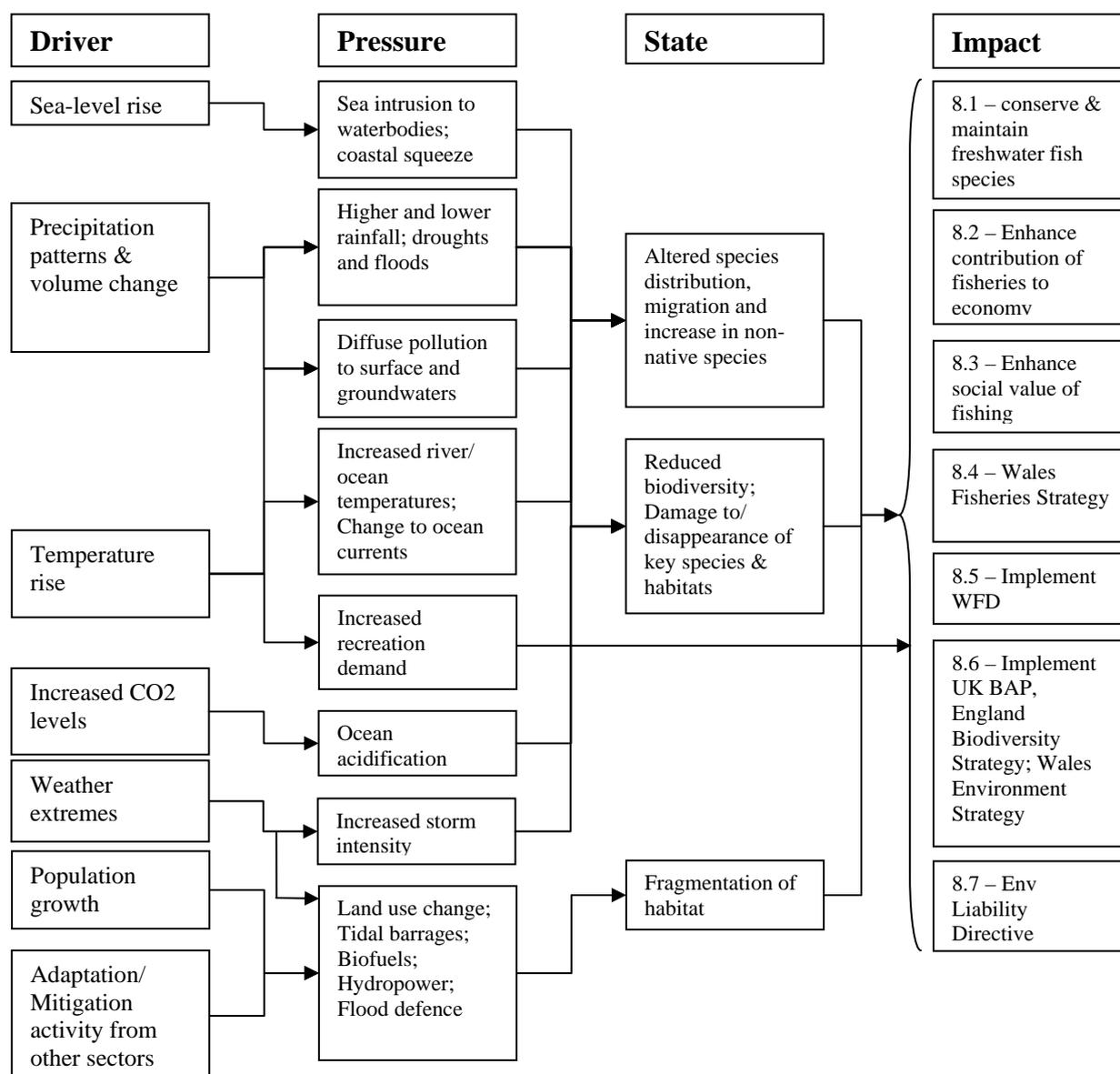
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Fisheries

Conceptual model of sensitive risks



Key evidence

- For this assessment we rely on the headline impacts identified by UKCIP02/UKCP09, alongside academic literature, our own evidence programme and research partnerships, to understand our potential risks, the expected direction and scale of change, and how we should adapt. Much of the accumulated evidence from which we draw conclusions has relied on more detailed consideration of climate change projections.
- Our monitoring (and that of others) provides evidence of climate change already affecting wildlife, habitats and fisheries.

Risks and actions

8.1 - We will ensure the conservation and maintain the diversity of freshwater fish, salmon, sea trout, eels, lamprey and smelt, and to conserve their aquatic environment.	
Impact	
	Rationale and uncertainty
Importance: Substantial	<p>Climate change presents an additional pressure on ecosystems already facing pressure from land-use change, pollution, over-fishing, demand for water, development pressures, renewable energy strategies and the introduction of non-native fish species. Further changes are expected in landscapes, ecological communities and populations structures as they respond to climate change impacts. This has the potential to devalue our freshwater and migratory fisheries and the contribution they make to the economy. Many of the predicted impacts may act in combination leading to further pressures on vulnerable species and habitats. Secondary effects are also likely to occur, such as changes in disease transmission, increased toxicity of pollutants, loss of salt-marshes and mudflats. Sea level rise and increased saline penetration would further compound the problems. This could make it harder to maintain the conservation and diversity of fish and could put our reputation at risk with our customers and stakeholders. Fish have evolved to cope with specific hydrologic regimes and habitat niches. Therefore, their physiology and life histories will be affected by alterations induced by climate change. Changes to water temperature leading to increased mortality of fish and changes in life history characteristics (size, run timing of salmon and trout) are already being seen in parts of the UK.</p> <p>Ensuring conservation of salmonids and their aquatic environments may be unachievable – there are signs that climate change is already having an impact in England and Wales. There is uncertainty about future climate predictions and therefore how climate change will impact on fish communities.</p> <ul style="list-style-type: none"> • Good evidence exists of salmon stock decline across its range despite increasing exploitation controls and improvements to waterbody environment – international advice is that this decline is heavily influenced by marine mortality linked to climatic effects. • Eel populations have changed dramatically in the last 30 years for a number of potential reasons including climate change. • It is assumed that changes may be less problematic for freshwater fish (for example carp, bream and roach) but this depends on the speed and degree of warming and whether/how soon habitats become fragmented and/or hostile. • Significant work still needs to be completed to establish the thermal preferences of fish.
Proximity: Now - Short term	
Confidence: Medium to High	
Response (to worst case impacts)	
Resource: Substantial	<p>We understand the nature of some of the types of response required although there are many uncertainties.</p> <ul style="list-style-type: none"> • A key assumption is that reducing existing pressures on wildlife will increase an ecosystems resistance and resilience to climate change. • It is assumed that we will quickly learn how to improve our approach to climate change adaptation by using ‘adaptive management’ (learning by doing) to reduce uncertainty. • The prediction of the impacts of climate change adaptation measures on fisheries can only be very general due to the uncertainties involved. • Climate change adaptation will need to be embedded into our current and future ‘ways of working’ in order to meet additional resource requirements.
Inertia: Rapid - Short term	
Confidence: Low to Medium	
Adaptation actions	
In the next year:	Costs
We will develop plans to manage the landscape to reduce temperature in rivers, lakes and estuaries, to increase summer base-flow in rivers, and to reduce diffuse pollution from sediment run-off.	M

We will ensure adaptation benefits are considered during development of a 'prioritisation tool' for fish passage needs and when prioritising fish passage projects.	L
We will continue work to investigate moving vulnerable species with poor dispersal capabilities, particularly where suitable habitat is remote from the current location (for example, Vendace, Schelly and other coregonids).	L
We will prioritise research needs to develop a strong evidence base to mitigate climate change impacts on fisheries.	L
We will take account of climate change impacts when providing technical input to Government for the development of new legislation and policies (for example, consultation for Fish Passage Regulations for all fish species). We will aid implementation of new legislation that will help mitigate climate change impacts (for example, resolve barriers to fish migration on structures we own/operate and review operating regimes for locks and weirs).	L
In the next 5 years:	
We will implement plans to manage the landscape to reduce temperature in rivers, lakes and estuaries, to increase summer base-flow in rivers, and to reduce diffuse pollution from sediment run-off.	M
We will continue to prioritise research needs and develop a strong evidence base. We will improve our understanding of climate change impacts on fish and fisheries to better inform ourselves, customers and help focus management action.	M
We will adopt ways of working in the implementation of new legislation that will help mitigate climate change impacts (for example, incorporate eel passes into our capital and maintenance programmes to meet requirements of the Eel Regulations 2009). This will help improve resilience of fish communities to climate change.	(H)
We will establish robust thermal standards for transitional and coastal (TraC) waters. For example, new nuclear power stations need large volumes of cooling water. They will be in operation (including decommissioning) for over 100 years. Partnership between the Environment Agency and our nuclear regulators to protect fish as much as possible by reducing fish impingement/entrainment and thermal discharges by exploiting new designs and methodologies.	(M)
We will identify those species and habitats that are most vulnerable by undertaking a vulnerability assessment. We will use the vulnerability assessment to better target existing measures. In consultation with experts, we will determine what additional action can be taken to reduce vulnerability.	M
Longer term actions:	
We will embed climate change into the strategic plan to tackle barriers to fish migration. Exploit opportunities to build fish passes in to new schemes (for example, capital asset maintenance and replacement, hydropower development, abstractions/discharges).	
We will adopt adaptive management: we will monitor to allow us to learn from what we do. Where uncertainties are high, implement measures as robustly designed experiments.	
Track the emerging adaptation and mitigation responses of other sectors (for example, renewable energy development) and assess the threats and opportunities for fish and fisheries.	
We will establish surveillance and early response plans for detecting the arrival of non-native invasive species.	

8.2 - We will enhance the contribution migratory and freshwater fisheries make to the economy, particularly in remote rural areas and in areas with low levels of income.

Impact

	Rationale and uncertainty
Importance: Minor - Moderate	Non-native species that are benign may become invasive under climate change scenarios, which could impact on the diversity of freshwater fish. There is a consequential risk of spread if the species is favoured by anglers. Climate change may have a significant effect on the fisheries of cold water species particularly

Proximity: Short-term	salmon and trout which make an important contribution to the economy particularly in remote, rural areas.
Confidence: Low	<ul style="list-style-type: none"> • While climate change may affect freshwater species available for fishing, this may not affect the economic viability of freshwater fisheries if anglers are willing to switch their target quarry. • However, there may be a greater risk to more remote rural economies that are more dependent upon salmonid fisheries and where there may be less opportunity and desire to fish for warm water species. • No impact on rod licence sales have been observed yet but salmonid net fisheries have declined – the number of licences issued has decreased by 70 per cent between 1985 and 2009. This has been driven by regulatory action for conservation reasons. • The biggest value associated with salmon and other fish is their existence and related values, especially as part of the wider ecology.
Response (to worst case impacts)	
Resource: Minor	There may be some switch from salmon and trout fishing to coarse fishing and also a switch to fishing in other parts of the UK but we are not yet picking up this change. If non-native species spread into our river systems this may reduce productivity of our native species due to disease transmission and competition for food and habitat. This could reduce the contribution migratory and freshwater fisheries make to the economy.
Inertia: Short-term	
Confidence: Low	
Adaptation actions	
In the next 5 years:	Costs
Increased partnership working – we will identify and influence external customers and third sector organisations who share our goals to aid development and implementation of fisheries strategies which will reduce pressures to fisheries and increase resilience to climate change impacts.	(M)
We will identify those species and habitats that are most vulnerable by undertaking a vulnerability assessment, especially salmonids. We will: <ul style="list-style-type: none"> - review current investments accordingly. - assess the value of commercial and recreational fisheries as species composition changes and varies spatially. - track effects on angling behaviour and trends in rod licence sales. 	L/M

8.3 - We will enhance the social value of fishing as a widely available and healthy form of recreation.

Impact

	Rationale and uncertainty
Importance: Minor	There will still be fish species to fish for – but the species composition may be different from now. It is assumed that people will be happy to fish for most species depending on what is available and that climate change itself will not diminish this desire. Impacts on cold water species are already being observed so the changes may occur by 2030, however this depends on the speed and degree of change and adaptation of native species. There may be a greater risk to more remote rural economies that are more dependent upon salmonid fisheries and where there may be less opportunity and desire to fish for warm water species.
Proximity: Short - Medium term	
Confidence: Low	
Response (to worst case impacts)	
Resource: Minor	We will change our approach to how we promote and enhance the social value of fishing.
Inertia: Short-term	
Confidence: Medium	

Adaptation actions	
As for 8.2 above	

8.4 - We will deliver the Wales Fisheries Strategy in collaboration with the Welsh Assembly Government.	
Impact	
	Rationale and uncertainty
Importance: Minor – Substantial	This objective is a combination of objectives 8.1-8.3, specific to Wales. Our assessment of risks are a combination of the assessments above. However, impacts on salmonid fisheries are likely to be proportionately greater in Wales due to their reliance on and the socio-economic value of these particular fisheries.
Proximity: Now – Medium term	
Confidence: Low – High	
Response (to worst case impacts)	
Resource: Minor - Substantial	As for risks 8.1-8.3 above.
Inertia: Rapid - Short term	
Confidence: Low – Medium	
Adaptation actions	
As for 8.1 and 8.2 above	

8.5 - We will implement the EC Water Framework Directive via the management of biological pressures, development and ownership of monitoring tools, and overseeing the design and implementation of Programmes of Measures.	
Impact	
	Rationale and uncertainty
Importance: Substantial	River Basin Management Plans should make a significant contribution to the reduction of existing pressures on fish. The delivery of these plans will become more difficult if climate changes as predicted. We are uncertain about how the climate will change. <ul style="list-style-type: none"> • There is some uncertainty about how much resource will be invested in River Basin Management Plans. • Uncertainty is also caused by the difficulty of allocating the proportion of change to particular pressures.
Proximity: Short term	
Confidence: Medium	
Response (to worst case impacts)	
Resource: Moderate	We have to reduce pressure on those fish species that are sensitive to predicted climatic changes now to reduce the rate of decline. However from a WFD delivery view, climate change may not have a significant impact on ecological status within the three cycles of WFD (to 2027). To maximise the outcomes for fish from River Basin Management Plans we need to modify these plans and their measures to optimise their benefits for climate change adaptation, while still achieving their primary objectives. Significant resources may be required. <ul style="list-style-type: none"> • We assume that we can work-out how to modify these plans to maximise their benefits for climate change adaptation for fish.
Inertia: Short term	
Confidence: Medium	

Adaptation actions	
As for 8.1 above	

8.6 - We will contribute to the implementation of the UK Biodiversity Action Plan, the England Biodiversity Strategy and the Wales Environment Strategy, and in particular the delivery of those actions for which the Environment Agency has lead responsibility.

Impact	
	Rationale and uncertainty
Importance: Moderate - Substantial	<p>Our objectives are already at risk due to concurrent pressures; climate change will exacerbate these. If we are seen to be failing our obligations for biodiversity then this is likely to have an impact on our reputation. We assume that the importance of biodiversity will be increasingly recognised and that increasingly, policy decisions will take account of the value of ecosystem services.</p> <ul style="list-style-type: none"> • While we are already failing our objectives, largely due to other pressures, the effects of climate change on ecology have already been recorded. • Uncertainty is caused by the difficulty of allocating the proportion of change to particular pressures. • We are uncertain about how the climate will change. • We are uncertain about society's response to future climate and the impact of that response on wildlife.
Proximity: Now	
Confidence: High	

Response (to worst case impacts)	
Resource: Substantial - Major	<p>It is widely accepted that, as a society, we need to do more if we are to halt the decline of biodiversity in a changing climate.</p> <p>To reduce the existing pressures on wildlife and adapt to climate change, there would have to be a step change in behaviour and investment across a wide range of stakeholders. This would require sufficient political will and willing support from stakeholders.</p> <p>We understand the nature of some of the types of response required although there are many uncertainties:</p> <ul style="list-style-type: none"> • A key assumption is that reducing existing pressures on wildlife will increase an ecosystem's resilience to climate change. • It is assumed that we will quickly learn how to improve our approach to climate change adaptation by using 'adaptive management' (learning by doing). • The prediction of the impacts of climate change adaptation measures on biodiversity can only be very general due to the uncertainties involved.
Inertia: Short-term	
Confidence: Low	

Adaptation actions	
As for 8.1 above	

8.7 - We will ensure that 'environmental damage' to protected species and natural habitats, and any imminent threat of such damage, in inland waters or from EA-regulated activities, is identified and addressed in accordance with the requirements of the Environmental Liability Directive.

Impact	
	Rationale and uncertainty
Importance: Negligible	Negligible impact
Proximity: N/A	
Confidence: Very high	

Response (to worst case impacts)	
Resource: None	Negligible impact

Inertia: None	
Confidence: High	
Adaptation actions	
As for 8.1 above	

Measures already implemented (for all Fisheries objectives)	Costs
Fish stocks are routinely monitored for conservation and fisheries management purposes and used to develop our fisheries strategies. Our monitoring seeks to provide us with an indication of changes in fish populations and potential causes, of which climate change may be one.	(M)
We have already commissioned studies to investigate climatic effects on fish and their populations.	M
Our fisheries strategies emphasise partnership working and we routinely work with external organisations to deliver our objectives. This will allow us to make a co-ordinated response to climate change and widely communicate the risk and responses required.	(M)
We work at a local level with landscape initiatives, such as Catchment Sensitive Farming, to improve conditions for fish; addressing diffuse pollution through Rural Sediment Tracing Project; projects associated with <i>Making Space for Water</i> policy which increase the areas of floodplains and reduce habitat fragmentation.	(M)
Delivery of over 100 multi-species fish passes were built last year through funding from Defra. These works will improve the resilience of fish species to climate change impacts and other pressures.	(H)
White fish translocation projects moving Vendace and Schelly from the Lake District to more suitable northerly locations in England and Scotland. This is a measure to ensure species do not become extinct and are able to better adapt to climate change.	(M)

Opportunities
<ul style="list-style-type: none"> Increased recreational opportunities arising from increased numbers of warm water coarse fish species, such as carp, bream and roach. In transitional and coastal (TraC) waters opportunities may be also be provided for commercially exploitable warm water species, such as bass.
<ul style="list-style-type: none"> Sustainable management of flood risk, such as creation of more wetland and coastal habitats and re-connection of floodplains. Urban habitat restoration programmes can provide a range of important functional benefits and are likely to have very significant social and educational benefits.
<ul style="list-style-type: none"> Evaluation of the main ecosystem services associated with inter-tidal habitat in TraC waters. Further elucidation will assist Cost Benefit Analysis of habitat creation options and help acquire additional funding support through cross-functional working. Similar opportunities may well apply with carbon offsetting, air quality improvement strategies and initiatives driven by WFD (for example, nutrient stripping function of TraC waters).
<ul style="list-style-type: none"> Increased opportunities for partnership working, for example working with Rivers Trusts to improve fish passage and habitats.
<ul style="list-style-type: none"> Influencing land management practices to enhance habitat connectivity and improve habitat for fisheries at risk from climate change impacts.

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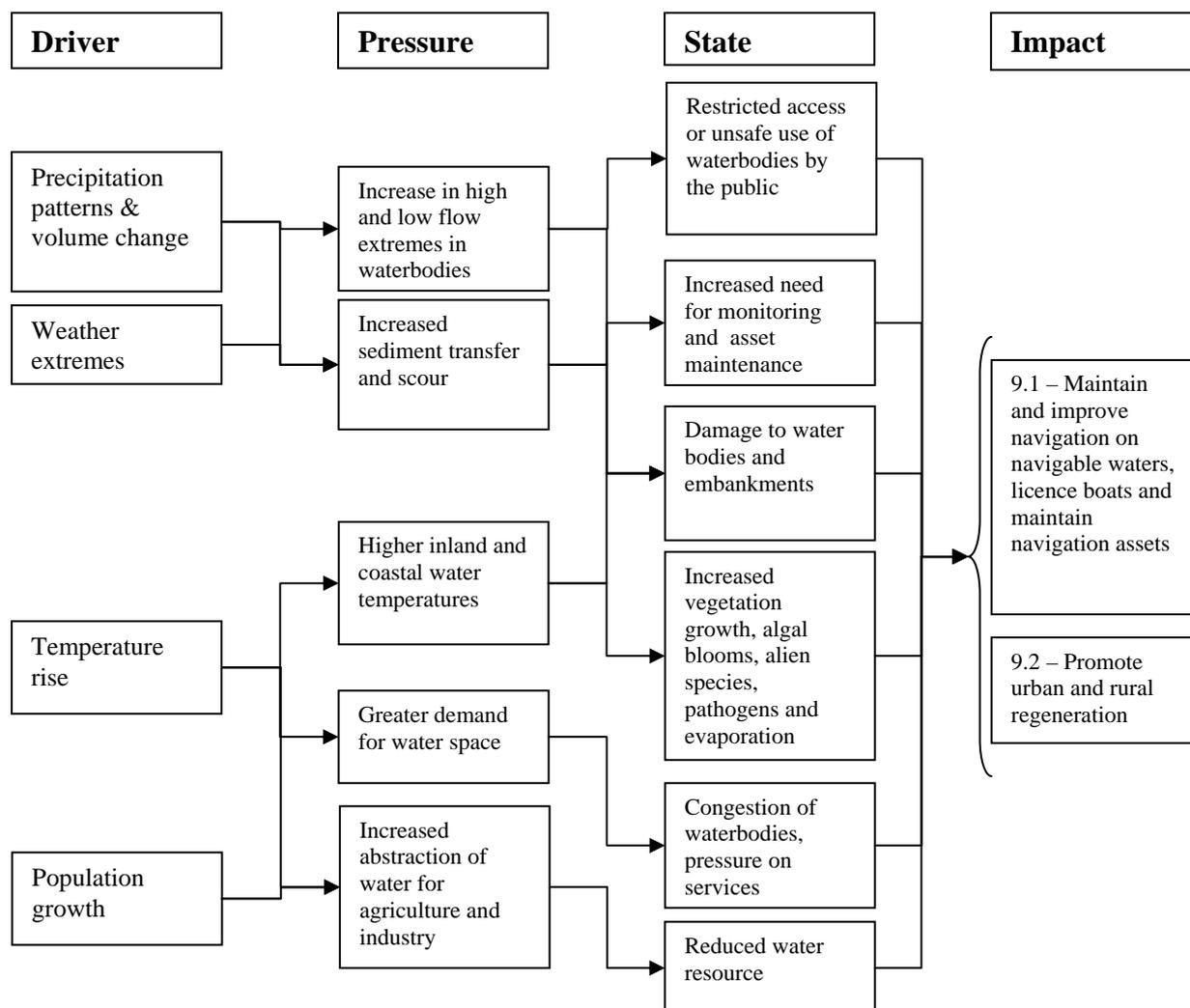
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Navigation

Conceptual model of sensitive risks



Key evidence

- We have modelled the potential climate change impacts on river flows in England and Wales by 2050, using UKCIP02 scenarios.
- We have assessed the impacts of climate change on high flow events and our use of “Strong-Stream Advice” notices using our 2050s river flows model
- We also rely on the headline impacts identified by UKCIP02 to understand the scale of potential risks to our Navigation objectives and how we should adapt

Risks and actions

9.1 - We will maintain and improve navigation on the navigable waters (mostly rivers) for which the Environment Agency has responsibility and licence boats using these waters as a statutory Navigation Authority; to maintain its assets in a condition which ensures the safe use of its waterways.	
Impact	
	Rationale and uncertainty
Importance: Moderate – Substantial	Drought is the most important expected impact from climate change on our navigation responsibilities, and this impact will depend on a number of factors including how we manage water resources and water resource assets (for example reservoirs) in the future. High flow events are of less significance, are more short term and people generally don't want to navigate waterways during these events anyway.
Proximity: Short - Medium term	An increase in the frequency of extreme low flow events would limit navigation through inadequate depth for boat passage and restrictions on lock operation. An increase in the frequency and degree of high flow events would severely limit navigation by making it unsafe to navigate and would increase the risk of physical damage to our assets and their potential failure. Increases to the temperature of our waterways, reservoirs and rivers are likely to result in additional vegetation growth, alien species, migration of existing species, pathogens and evaporation which could restrict safe and sustainable use of water for some recreational activities and increase the levels of maintenance required. Resource demands for this objective during drought periods could adversely affect the delivery of other objectives and other departments in the Environment Agency, but there could also be an impact on the Environment Agency's reputation during low flow events.
Confidence: Medium	Physical impacts on embankments due to drought and flooding could be significant one-off costs, however our response is likely to be reactive. <ul style="list-style-type: none"> • There is uncertainty about when a change to existing practice would be required. • A change to existing practice will involve a significant change to frequency of navigation restrictions, 'Strong Stream Advice' notices, maintenance requirements and so on. • Increased use of waterways due to population growth may have a negative impact on our navigation resource due to greater demand for facilities, congestion, competition for water space and pressure on services.
Response (to worst case impacts)	
Resource: Major	We need to research and quantify how probable changes to river flows will affect the management of the navigation channel and other infrastructure (that is, in respect of dredging, scour and so on). Indicative estimates for the Thames, using (relatively dry) UKCIP-02 scenarios, suggest that our existing operating and asset management approaches are appropriate to respond to changes in flood flows.
Inertia: Short-term	However, other probabilistic models, (UKCIP-09), are likely to demonstrate considerable variation between our regions. Further modelling is required at finer spatial and temporal scales to evaluate the specific impacts of high flows upon each of our waterways.
Confidence: Medium	One-off costs from embankment failure could cost several millions of pounds. With advance planning, reinforcing existing structures could be undertaken quickly (rapid), but the likelihood of occurrence are so small that it may not be worth taking action. <ul style="list-style-type: none"> • There are a number of uncertainties around geomorphology, topography and their impact on low flows and navigation.
Adaptation actions	
In the next year:	Costs
None	-
In the next 5 years:	

We will record, manage and compare data with other navigation authorities on frequency of operational measures to respond to environmental processes (such as spot dredging, weed growth, or changes to vegetation management across navigation assets). We will continue to consider and evaluate new climate change information/modelling undertaken by other functions to ensure that our maintenance of navigation assets is robust enough to react to change (including best available data modelling on high flow events, increases to evaporation rates, vegetation growth, spread of invasive non-native species and occurrence of algal blooms). We will review strong stream data and 30-day duration mean flows to highlight trends that could affect current risk-based approaches being taken to maintenance, asset management and strong stream advice/management.	L
Should risk of drought conditions occur we will develop practices to seek to maintain a minimum flow and manage lock movements.	L
Longer term actions:	
We will work to identify changes in management practices that may help adapt to climate change through WFD, fisheries and flood risk management.	

9.2 - We will promote urban and rural regeneration.	
Impact	
Importance: Negligible – Minor	Rationale and uncertainty We will promote urban and rural regeneration in tandem with our delivery of objective 9.1
Proximity: Short – Medium term	
Confidence: Medium	
Response (to worst case impacts)	
Resource: Minor	
Inertia: Rapid	
Confidence: Medium	
Adaptation actions	
As for 9.1 above	

Measures already implemented (for all Navigation objectives)	Costs
We have reviewed our current baseline of Strong Stream Advice, low flow and other climate related data (SSA thresholds and 30 day duration mean flows have been adopted by waterway managers as a way of monitoring effects of climate change on our navigations).	L
We ensure engineering standards, performance and sustainability criteria are applied to navigation assets. Standards for more extreme high flows are aligned with Defra and current Environment Agency guidance and research for flood risk management.	L
We have reviewed current operational processes and how they may need to adapt to climate change (including health and safety, increased visitors and so on).	
We have developed a clear position statement for navigation and climate change for our external audience. <ul style="list-style-type: none"> We promote key messages with internal and external partners. We develop and deliver guidance for staff to promote climate change awareness and understanding, including the dissemination of the Recreation & Navigation climate change adaptation plan. 	L
We review and promote adaptation methods with external contacts and partners.	L
We assess – with wider external partnerships – the effect of climate change on a potential increase in interest in, and opportunities to develop waterways for freight.	L

Measures which have been ruled out	Rationale
Evaluate approaches, costs and potential value of maintaining a minimum flow during drought conditions.	Will be undertaken/developed in reaction to drought risk due to site specific and temporal differences in impacts.
Investigate opportunities to promote improved boat design, channel maintenance, and changes to locking practice.	This is for the boating sector to develop. Minimum channel maintenance will be undertaken to keep waterways open. Existing low-flow lock practices will be reviewed, amended and implemented as needed to respond to risk and balance environmental/economic demands.
Scope potential impacts of multi-season droughts and water framework directive on future operation of navigations under low flow conditions.	Some initial scoping work carried out to identify impacts and options. Limited impacts and risks found, with few alternatives to justify more in-depth investigation/investment.

Opportunities
<ul style="list-style-type: none"> • Increased potential for freight use on our waterways as carbon neutral alternative.
<ul style="list-style-type: none"> • Systems which safeguard minimum flow could help to conserve existing biodiversity and add to species' resilience.
<ul style="list-style-type: none"> • The threat of low flows could inspire improved boat design.
<ul style="list-style-type: none"> • Continue to monitor economic viability of green power generation schemes, carbon neutral solutions in towns and cities (for example use of water to cool buildings) for potential application across waterways.
<ul style="list-style-type: none"> • Where our navigation interests overlap with local sustainable transport initiatives, work with others to provide more sustainable solutions (that is, solar water taxi, commuting cycle/walking routes to town/city centres and so on).
<ul style="list-style-type: none"> • Act as an exemplar of best practice in low carbon, ethical design and build of replacement or new waterway structures and facilities.
<ul style="list-style-type: none"> • Providing local recreation opportunities on local waterways, therefore reducing the need for users to travel farther afield.

Key references

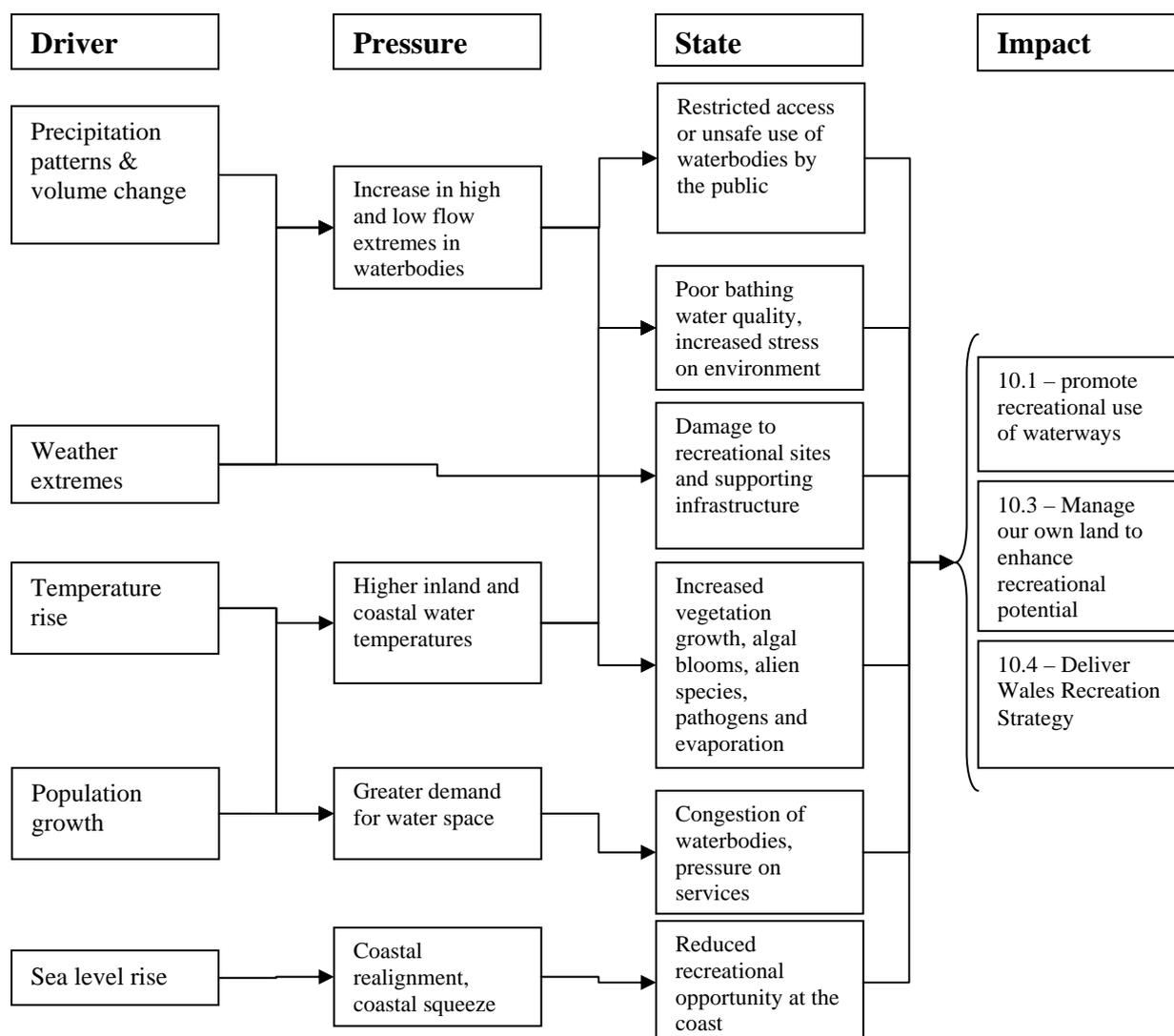
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Recreation

Conceptual model of sensitive risks



Key evidence

- We rely on the headline impacts identified by UKCIP02 alongside academic literature to understand the types of impact, the direction of change in people's behaviour, the potential risks to our objectives and how we can adapt

Risks and actions

10.1 - We will promote greater recreation, in particular for the use of waterways we manage by all sectors of society, and provide improved facilities for users.	
Impact	
	Rationale and uncertainty
Importance: Minor	We expect temperature increases will result in growing demand for water-related recreation activities. Demand will increase from a larger population, more UK tourists staying at home and a greater number of international visitors as traditional destinations nearer the equator become uncomfortably hot. Increased use may have a negative impact on the resource with greater demand, congestion, competition for water space and pressure on services. In the short to medium term many impacts may be positive rather than negative, and provide a number of opportunities to enhance the recreational value of waterways and our own land.
Proximity: Short - Medium term	Increases to the temperature of our waterways, reservoirs and rivers are likely to result in additional vegetation growth, toxic and algal blooms, alien species, migration of existing species, pathogens and evaporation which could restrict safe and sustainable use of water for some recreational activities and increase the levels of maintenance required. Higher evaporation rates, low summer rainfall and high demand for abstraction may severely limit the availability of many inland waters for recreational use. An increase in water retention times in low flow conditions may lead to more weed growth, which would increase the need for greater monitoring and maintenance. Storm damage to buildings, harbours, woodland/trees, gardens, caravan and camp sites, especially in exposed locations may become an increased threat. Temporary loss or closure of infrastructure - power lines, roads, rail lines, and coast paths severed by storm damage or flooding may also become a more frequent threat.
Confidence: High	<ul style="list-style-type: none"> • There is potentially a risk to our reputation. • We assume that there are no systemic delays; when the weather is warmer, there will be an immediate increase in visitor numbers. • Population growth is likely to increase pressure on our recreational objectives.
Response (to worst case impacts)	
Resource: Moderate	Climate change is unlikely to mean a change to what we do, we will just be doing more of it. For example, increased number of accidents will mean more inquiries, notices and so on. It is difficult to assess exactly when this may become a problem, given our existing knowledge of climate impacts. <ul style="list-style-type: none"> • We understand the dynamics of climate risks to people's behaviour, and understand what is needed to respond. • Land is managed by different parts of the Environment Agency. As impacts increase, resources may need to be redistributed across functions.
Inertia: Rapid	
Confidence: Very high	
Adaptation actions	
In the next year:	Costs
None	-
In the next 5 years:	
We will respond to high risk issues, particularly for land and water-access management issues (for land owned by the Environment Agency), Parliamentary Questions and media enquiries to promote safe, responsible use of our water and waterside holdings where demands and pressures change (including coastal realignment).	L
We will respond to external organisations and media in promoting safe, responsible use of water environment as demands/pressures change.	L
We will review probabilistic modelling of impacts prepared for other functions to identify any significant changes to our existing knowledge of nature, frequency and timescale of impacts.	L

Longer term actions:
We will review/climate change proof our practices for providing recreational opportunities on our holdings and our duty of care for increasing numbers of people who may trespass for recreational purposes.
We will consider projected climate change impacts in the way we broadly promote greater recreational use of water, in our provision of recreational facilities for users, and in the enhancement of the recreational and cultural potential of our own land.
We will help to inform debate on local conflict resolution as competition and demand for limited water/water space escalates.

10.2 - We will manage our own lands to enhance their cultural and recreational potential.	
Impact	
	Rationale and uncertainty
Importance: Negligible – Minor	Our own lands and their cultural and recreational potential will be subject to the same impacts described for objective 10.1.
Proximity: Short – Medium term	
Confidence: Medium	
Response (to worst case impacts)	
Resource: Minor	Our existing activity is unlikely to change until severe impacts force a reactive change (for example, restricting access to our land). Responses to extreme impacts are unlikely to be resource intensive and can be implemented quickly. Land is managed by different functions within the Environment Agency. As impacts increase, resources may need to be redistributed across functions.
Inertia: Rapid	
Confidence: Medium	
Adaptation actions	
As for 10.1 above	

10.3 - We will work to deliver the Strategic Plan for Water Related Recreation in Wales.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Climate change will not affect the delivery of this objective. However it is important that we use this objective to encourage adaptation in others.
Adaptation actions	
In the next year:	Costs
None	-
In the next 5 years:	
We will ensure that implementation of the plan and new provision is undertaken with climate change in mind.	L

Measures already implemented (for all Recreation objectives)	Costs
We review current operational processes and how they may need to adapt to climate change (including health and safety, increased visitors etc).	L
<ul style="list-style-type: none"> We have developed a clear position statement on recreation and navigation and climate change for our external audience. 	L

<ul style="list-style-type: none"> • We promote key messages with internal and external partners. • We develop and deliver guidance for staff to promote climate change awareness and understanding, (including the dissemination of our climate change adaptation plan). 	
We assess with wider external partnerships the effect of climate change on recreational and tourism demand for waterways.	L
We review and promote adaptation methods with external contacts and partners.	L
Measures which have been ruled out	Rationale
Review of health and safety practices and procedures for our sites	Our current procedures are considered sufficiently robust to handle changes in trends, types and frequency of uses. Where this cannot reasonably be achieved then access to sites would be closed where public health and safety can no longer be controlled.
Further modelling of regional impacts of climate change	Greater probabilistic analysis of regional differences in the impact of climate change is unlikely to significantly alter the systems or advice in place to respond to changing pressures, risks and demands on our sites.

Opportunities

<ul style="list-style-type: none"> • Increased recreational and tourism demand. • Systems which safeguard minimum flow could help to conserve existing biodiversity and add to species' resilience. • Greater demand for recreational opportunities closer to where people live. • New recreation opportunities - shark watching, new tourism industries and so on. • Responding positively to the climate change agenda to develop renewable energy schemes on some of our assets. • Opportunity for climate change to be used a focus for regenerating waterbodies in towns and cities to provide carbon free sustainable transport spines. • Act as an exemplar of best practice in low carbon, ethical design and build of replacement or new waterway structures and facilities. • Influence better provision of water and land based recreation across land management functions to respond to strategic and targeted community needs (reducing need to travel significant distances for demanded leisure opportunities for example white water playsites in Anglian/SE).

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Viner D., 2006. Tourism and its Interactions with Climate Change. *Journal of Sustainable Tourism*, Vol 14 Nos. 4 -.

Sustainable places

Conceptual model of sensitive risks

No sensitive objectives

Risks and actions

11.1 - Better local environments enhance people's lives and support a sustainable economy.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Not sensitive to climate change but we may use this objective to work with others to adapt; or adjust its implementation to ensure that our work is not causing adverse responses from others.
Adaptation actions	
In the next year:	Costs
We will co-ordinate the prioritisation of environmental issues with local authorities. This will include objectives linked to adaptation.	L
In the next 5 years:	
Continue to support prioritisation of environmental issues with local authorities.	L

11.2 - New and existing developments have a reduced environmental impact and well planned environmental infrastructure.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Not sensitive to climate change but we may use this objective to work with others to adapt; or adjust its implementation to ensure that our work is not causing adverse responses from others.
Adaptation actions	
In the next year:	Costs
Work with policy makers, developers and other partners to provide evidence on sustainable building standards for both new and existing developments. In the next year this will include work on retrofitting good practice and on energy and water efficiency.	L
Advise and support local staff to inform the delivery of significant housing growth projects, to ensure they mitigate negative impacts and maximise opportunities to enhance their local environments. This will include providing evidence to input into water cycle studies and environmental infrastructure studies.	L
In the next 5 years:	
As above.	

11.3 - Spatial and economic planning meets environmental standards and objectives, and addresses climate change.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not sensitive	Not sensitive to climate change but we may use this objective to work with others to adapt; or adjust its implementation to ensure that our work is not causing adverse responses from others.

Adaptation actions	
In the next year:	Costs
In England, we will carry out work to ensure that Local Economic Partnerships are informed about environmental limits and take into account future climate risks. In Wales, continue to contribute, where appropriate, to the community planning process including Local Service Boards and Local Delivery Agreements and the Wales Spatial Plan groups.	L
We will advise Governments in England and Wales on reforms to national, sub-national and local planning decision making structures and forthcoming policy and legislation.	(L)
We will work with Planning Authorities in England and Wales to ensure that spatial strategies (local and sub-national) respect environmental limits and take into account future climate risks.	(L)
We will work with Governments in England and Wales and other stakeholders to help deliver the Planning Act and policy for Nationally Significant Infrastructure Projects.	(L)
We will maintain our good relationship with the Infrastructure Planning Commission and highlight climate change in our work with infrastructure developers.	(L)
We will work in partnership to promote the wider adoption of sustainable building standards for both new and existing developments.	(L)
We will help ensure Environmental Assessments address future climate impacts.	(L)
We will update our existing Guidance on Strategic Environmental Assessment (SEA) and Climate Change for external users, to encourage integration of climate change considerations in the SEA process.	(L)
We will liaise with the Department for Communities and Local Government and WAG to help include climate change considerations in future Environmental Impact Assessment (EIA) guidance.	(L)
We will use our statutory consultee role in planning to incorporate climate change considerations in SEA and EIA documents, and to Sustainability Appraisals.	(L)
We will work in partnership with Governments in England and Wales and the UK Climate Impacts Partnership to help advise planners and developers on UKCP09.	(L)
We will work in partnership with Governments and other agencies to help advise on climate change adaptation issues for the built and natural environment.	(L)
In the next 5 years:	
We will ensure our work uses good practice case studies.	(L)
We will ensure communications work integrates adaptation and resource efficiency messages.	(L)

Measures already implemented (for all Sustainable Places objectives)	Costs
We worked with the Department of Communities and Local Government and stakeholders to inform the criteria for development for eco-towns and growth point development so they are resilient to the long term impacts of climate change.	M
We worked in partnership with local authorities to deliver NI188 in England and our commitments in Local Delivery Agreement in Wales including outcomes that reduce climate change risks.	M
We commissioned evidence on future land use pressures particularly in relation to the impacts on water availability and flood risk management.	L
We have ensured that planning applications for major development which we have sustained an objection to on flood risk grounds are notified to the Secretary of State under the 'Call in' Direction (England only).	L
We have advised Governments on including climate change adaptation in national planning policy and through Strategic Environmental Assessments and Appraisals of Sustainability.	M
We have provided advice to our own staff on advising local authorities on climate change adaptation.	M

Opportunities
In England, realise opportunities arising through localism agenda, including the role of Local

Economic Partnerships, to address and respond to climate change adaptation.

Realise opportunities in planning reform in England for climate change adaptation including National Planning Framework, Community Right to Build and a new designation to protect green areas of particular importance to local communities.

Key references

UK Climate Impacts Programme, 2002. *Climate change scenarios for the United Kingdom*. UKCIP.

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http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=161&Itemid=291

Climate change and energy

Conceptual model of sensitive risks

No sensitive objectives

Risks and actions

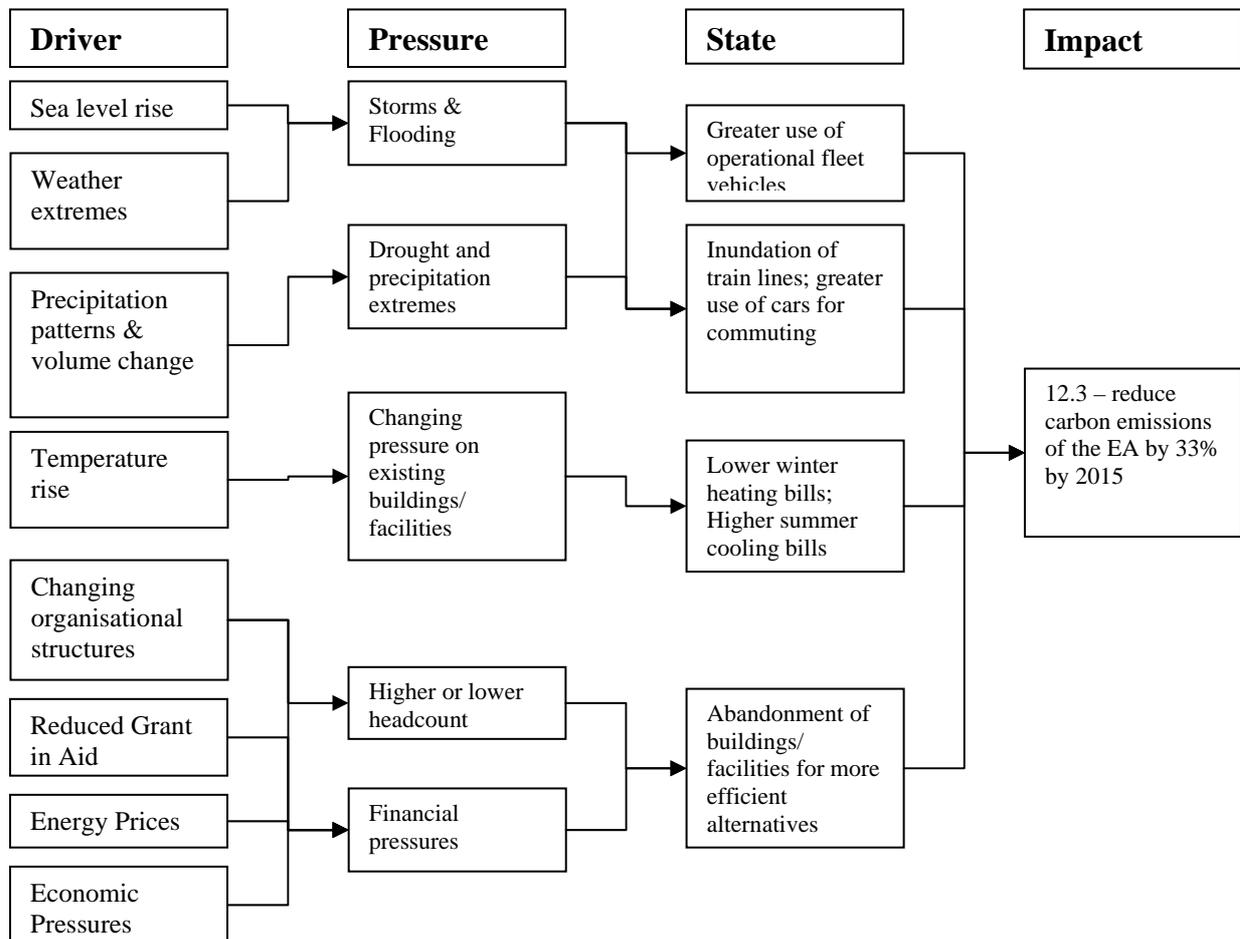
12.1 - We play our full part in helping England and Wales meet greenhouse gas emissions targets in ways that minimise other environmental impacts. This includes administering the EU Emissions Trading System and the CRC Energy Efficiency Scheme efficiently.	
Impact	
	Rationale and uncertainty
Influenced by climate change but not directly sensitive.	Climate change is unlikely to have a direct impact on our role in helping England and Wales to meet greenhouse gas emissions targets. However we must ensure that our efforts do not conflict with, and where possible help, the adaptation efforts of ourselves and others.
Adaptation actions	
In the next year:	Costs
We will carry out a project to research the energy sector's use of water. The project will explore the sustainability of the sector's demand for water given likely changes in energy generation and the impact of climate change on water availability.	L
We will publish our revised good practice guide for small scale hydropower which sets out the standards that we believe need to be met in order for them to be designed and delivered sustainably and not prevent future adaptation of freshwater species and habitats.	L
In the next 5 years:	
We will ensure that our mitigation activities consider the sustainability of low carbon technologies and, where appropriate, incorporate the need for climate change adaptation in their design and delivery.	L

12.2 - We help people and wildlife adapt to climate change and reduce its adverse impacts.	
Impact	
	Rationale and uncertainty
Importance: Severe	<p>Note: Risk 12.2 is not included in our strategic risk assessment since it is the cumulative effect of all other risks set out in this report.</p> <p>In summary, our assessment shows that:</p> <ul style="list-style-type: none"> Climate change will affect almost everything we do. Our priority risks are to inland flooding, coastal flooding and erosion, water resources and quality, wildlife and habitats. We need to manage specific risks in other areas of our business and adapt how we work to achieve the same outcomes. Partnership working is essential for adaptation and we are working closely with central and local government, local communities, businesses and the third sector. Many of our climate risks interact and need to be managed together. <p>We will update our risk assessment and adaptation plans as our evidence improves or our remit changes.</p>
Proximity: Now	
Confidence: V. low – V. high	
Response (to worst case impacts)	
Resource: Major	The other sections of this annex list the specific actions we have taken already and those we plan to take to address risks to individual business objectives. They span the full range of resources (some are simple and easy to do whereas others will require significant effort) and inertia (we can implement some very quickly
Inertia: Rapid - Medium	

Confidence: V. low – V. high	whereas others will take longer to be effective). We are very confident that some will have the desired effect but we are less confident about others and will implement flexible solutions and learn as we go, adjusting our approach as necessary. In addition to taking these actions we also need to ensure there is strong leadership, appropriate governance, structures and ways of working. Our adaptation programme will be structured and run to ensure that, as an organisation, we take steps to adapt in a holistic and integrated way. This includes prioritising our actions, learning from experience, developing adaptive capacity and ensuring that we gather and interpret evidence to improve our understanding of possible future impacts on our organisation.
Adaptation actions	
In the next year:	Costs
We will implement an adaptation programme to coordinate and integrate our actions to help people and the environment adapt.	M
We will continue to embed consideration of climate change in everything we do. This will enhance the way we understand and communicate about climate change, and how we work with impacts, risks and responses across the organisation.	L
We will continue to provide training, tools and guidance to our staff to ensure they have the skills and knowledge they need to address climate change in their roles. This will include guidance to all staff to allow them to use the UK Climate Projections (UKCP09) in an appropriate and consistent manner.	M
We will continue to share our experience, knowledge and data with key partners, such as Government departments, the Climate Change Commission for Wales, local authorities, businesses, and where appropriate, the public.	M
We will continue to collect and interpret data, undertake modelling (for example using UKCP09) and research to improve our knowledge and the evidence base to underpin our own decisions and the work we do with all our partners.	M
In the next 5 years:	
We will play our full part in the delivery, as required, of the first National Adaptation Programme, due in 2012.	M/H
We will monitor and report on progress in embedding consideration of the future climate in everything we do.	L
We will monitor delivery of this adaptation report and the wider adaptation programme and, if required, review and revise this risk assessment under subsequent iterations of the Reporting Power directions.	L

Our carbon emissions

Conceptual model of sensitive risks



Key evidence

- We rely on the headline impacts identified by UKCIP02/UKCP09 to understand the range and scale of potential impacts projected within the limited timescales of our emissions reduction objectives

Risks and actions

12.3 We will reduce the Environment Agency’s carbon emissions by 33 per cent by 2015 from 2006-07 levels.

Impact

Rationale and uncertainty	
Importance: Negligible	We may expect to see climate change impacts on our carbon reduction targets in the future. Increased frequency of flooding incidents may require more water pumping and operational use of vehicles and boats. Intense flooding events may cause damage to roads leading to greater need to take longer routes, or cause train lines to be inundated more often leading to an increased reliance on cars for travel. These types of impacts may lead to our Internal Environmental Management mileage and carbon dioxide targets being missed. However there are unlikely to be impacts on our current carbon reduction objective given the timescales involved. There are a number of competing economic, business continuity and statutory pressures which are likely to take
Proximity: Short-term	

Confidence: Medium	higher priority in the event of significant climate change causing a potential failure of our carbon reduction target over these timescales.
Response (to worst case impacts)	
Resource: Minor	The most extreme ranges of the most up to date climate projections (UKCP09) would be very unlikely to affect our current carbon reduction target. Business as usual fluctuations in our carbon emissions are more influential and we have many initiatives already underway to minimise them and to make our ways of working more efficient. It is likely that operational requirements will take priority over meeting carbon reduction targets in the future if there are worst-case impacts.
Inertia: Long-term	
Confidence: Medium	
Adaptation actions	
None	

Measures already implemented (for all Climate Change and Energy objectives)	Costs
We have completed a range of projects to understand the impacts from climate change and risks to our organisation, including: <ul style="list-style-type: none"> providing guidance to help us understand UK Climate Projections 2009 (UKCP09) and how to use them effectively in our work; understanding the potential climate impacts on river flows by the 2050s. 	(H)
We published our first adaptation strategy in 2005, updated it in 2008 and climate change now features prominently in our corporate strategy. We have been taking actions to understand climate risks and address them for several years and all this work has informed the content of this report.	M
We have a national training programme which ensures that all staff have at least a foundation-level of knowledge of climate change and our role in managing it. This has face-to-face and e-learning components, with important messages regularly reinforced through our main organisational communication channels.	L
We consider climate change as a key element in business planning, and we are monitoring progress to ensure that all parts of the Environment Agency are progressing their understanding of climate change impacts and developing and implementing appropriate responses.	L
We have integrated adaptation into key technical advice and guidance (for example flood risk allowances, water resource planning, land use planning guidance and the Water Framework Directive), which target other sectors.	M
We have developed opportunity maps for hydropower and biomass projects to ensure their location is sustainable and does not compromise our ability to adapt.	M
We ensure that existing guidance on environmental assessment includes adaptation.	L
We have implemented energy efficiency measures like Voltage Optimisation (VO). There has been approximately 10 per cent reduction in electricity use at all sites where VO has been installed. This will help us towards meeting our target despite extra A/C requirement.	M
De-carbonising our energy with renewables.	N/A
We continue to promote alternatives to travel such as web conferencing.	(L)

Opportunities
<ul style="list-style-type: none"> A smaller business is likely to lead to a smaller carbon footprint. Higher winter temperatures may decrease the need for heating in the winter, saving energy. Climate change impacts may lead to new legislation requiring and funding more renewable infrastructure, thus helping our efforts. Increased frequency of flooding may lead to abandonment of certain buildings to more efficient locations - our energy use at new buildings will be reduced compared to the abandoned ones. Wind patterns may become more favourable for turbine development, as may fluvial systems – We will buy less grid power, thus reducing our footprint. If our policy teams follow their adaptation plans and implement inventive solutions this may reduce our impact.

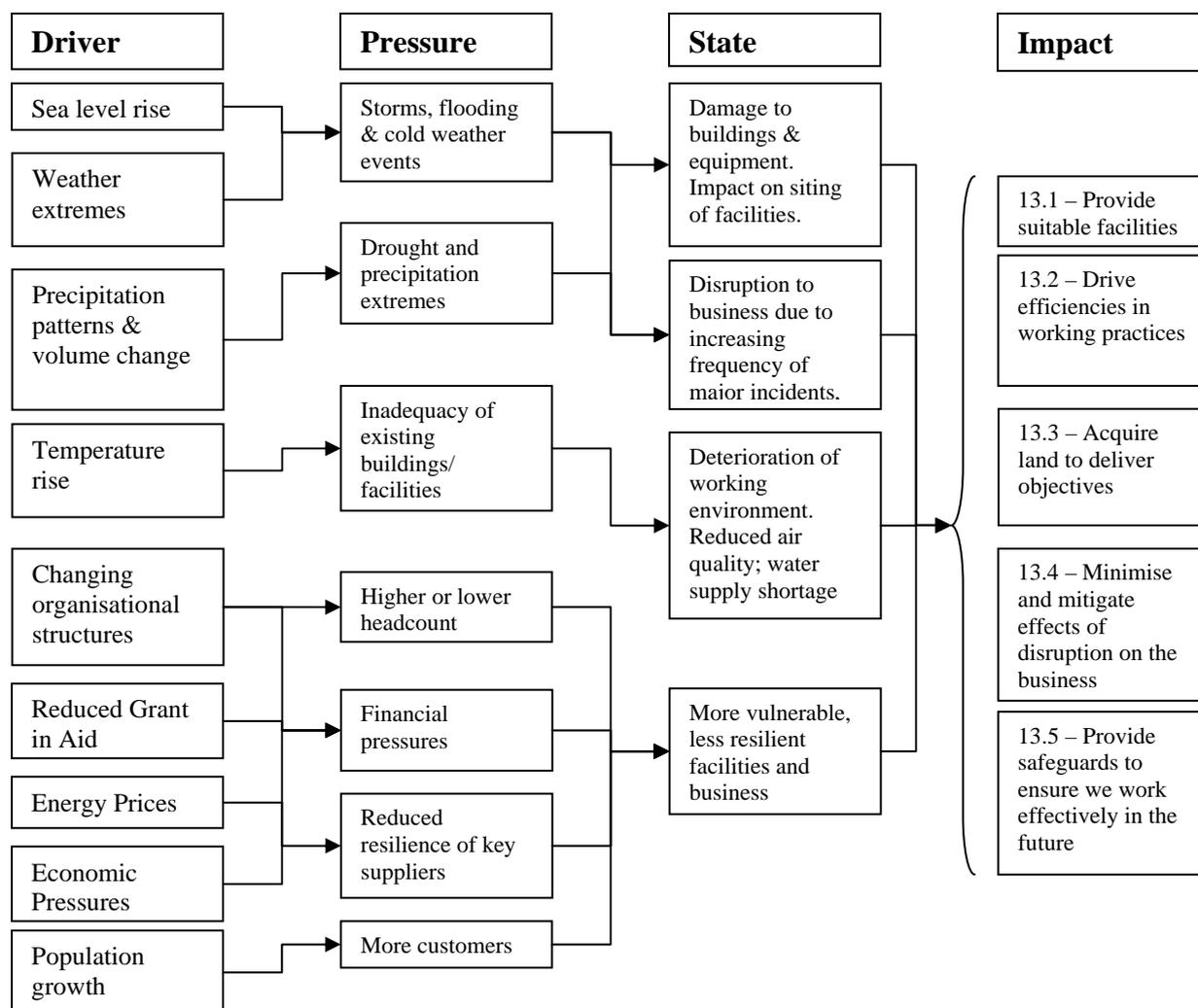
Key references:

UK Climate Impacts Programme, 2002. *Climate change scenarios for the United Kingdom*. UKCIP.
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UK Climate Projections, 2009. *Climate change projections for the United Kingdom*. UKCIP.
Available online at: <http://ukclimateprojections.defra.gov.uk/content/view/12/689/>

Our business continuity and estates

Conceptual model of sensitive risks



Key evidence

- We rely on the headline impacts identified by UKCIP02/UKCP09 to understand the range and scale of potential impacts on our incident management and contingency planning
- We assess flood and water resources risk to critical assets on a case by case basis using catchment-scale information.

Risks and actions

13.1	We will provide suitable facilities (property, fleet and other assets) to support employees roles and the delivery of our corporate strategy.
13.3	We will acquire land to deliver our functional objectives.
13.4	We will minimise and mitigate the effects of a disruption on the business from an unforeseen event, plus meeting the requirements of the Civil Contingencies Act.
Impact	
	Rationale and uncertainty

Importance: Moderate	<p>Currently we rely on very few individual sites for unique business critical functions (most are replicated elsewhere within the organisation), and therefore our vulnerability to climate change as a result of impacts to any individual site is low.</p> <p>Impacts on individual offices may be substantial, and the flexibility of our response may be constrained by the fact that we have long term leases on certain assets and sites (that is, it may be difficult to abandon a particular site). The way we work now (the ability to work remotely) gives us flexibility overall.</p> <p>Short-term impacts are unlikely to derail pretty robust procurement and business continuity systems for estates and facilities. The number of people and locations devoted to business critical systems is quite low, and our building location procedures, fleet procurement and so on are robust and unlikely to change substantially in the face of climate change. Climate change may eventually affect our working arrangements, but it is unlikely to impact the functionality of the wider organisation.</p> <ul style="list-style-type: none"> • We are becoming more dependent on third parties for key services – contracts must specify the need for resilience. In Wales there is a move to buy services from small and medium enterprises; the resilience of their service provision could be impacted upon in the same way as the Environment Agency’s if located in similar geographical locations. • We need to establish centrally which of our sites are in flood risk areas. • We haven’t undertaken detailed analysis of the vulnerability of our estates – this may be necessary.
Proximity: Medium-term	
Confidence: Low	
Response (to worst case impacts)	
Resource: Moderate	<p>We review our activities against a range of criteria (impact categories) as part of the BIRA (business impact risk assessment) process. These impact categories include legal/statutory, communities and people, environment, reputation, financial, internal functions and other agencies or Government departments. The effects of climate change, and our adaptation to them, including our incident management strategy, will be considered as part of this process, but cannot be disaggregated from it.</p> <p>More of our buildings could become inaccessible and we may have to move staff around. We may also need to mothball sites which are vulnerable, however most climate change impacts are likely to be short term events and our response is likely to be reactive.</p> <p>We don’t think about long term impacts from climate change in terms of our Business Continuity Management and we may be vulnerable in that respect. None of our leaseholds have backup/contingency however the consequences of their failure is small given the low importance of individual sites and therefore our limited vulnerability.</p> <p>We may also be moving toward sharing space with other government departments as a result of an impact. In Wales we are moving towards sharing space with other WAG sponsored bodies</p> <ul style="list-style-type: none"> • Long term leases mean that making changes to our property portfolio is medium term but financial constraint could mean it is long term. • Process changes and responses from staff and sites etc would probably be rapid.
Inertia: Rapid – Long term	
Confidence: Low - Medium	
Adaptation actions	
In the next year:	Costs
We will undertake further analysis to understand where our greatest vulnerabilities lie.	L
In the next 5 years:	
We will tackle our highest priority areas (causes of disruption) such as utilities supply.	L
We will put in place mitigation measures and identify alternatives for delivery.	L
Longer term actions:	

We will continue to take climate change into account when reviewing our incident management strategy and in the provision of suitable facilities to support employees roles.

13.2 We will drive efficiencies in our working practices and ensure high utilisation of our assets.

13.5 We will provide suitable safeguards to ensure our people, systems and property work effectively in the future. To find more efficient ways of coping with disruption, through contingency planning, alternative ways of working and so on.

Impact

	Rationale and uncertainty
Importance: Negligible – Minor	Efficiency targets may change and our objectives will be set relative to shifting priorities. Climate change may impact on our efficiency but this is likely to be a positive impact (we will make stronger commitments rather than weaker ones as a result of climate change). A change to our existing work practices will depend on climate change as well as concurrent pressures such as financial pressures on the Environment Agency, energy prices, technology development etc. Our objective to put systems in place to make our Business Continuity Management (BCM) more resilient will require us to consider in more detail the range of possible climate change impacts than we do currently. This is not necessarily an impediment to this objective, and considering climate change will make BCM more resilient overall.
Proximity: Short - Medium term	
Confidence: Very Low	

Response (to worst case impacts)

Resource: Minor	<ul style="list-style-type: none"> • Efficiency measures are likely to pay for themselves. • We need to ensure that our suppliers have sufficiently robust systems in place to ensure service to us. • We could reduce uncertainty by improving our understanding of the vulnerabilities of individual sites.
Inertia: Rapid	
Confidence: Medium	

Adaptation actions

In the next year:	Costs
We will review whether our suppliers are considering the resilience of their operations to climate change and that we test / confirm the suitability of existing contractual arrangements to be able to cope with climate change impacts. For instance, specific supply chain or supplier resilience, or how high a priority maintaining a service to the Environment Agency is relative to those services supplied to their other clients.	L
In the next 5 years:	
We will continue to take climate change into account in the provision of suitable facilities to support employees roles and our corporate strategy.	L
We will review our activities in more detail under BIRA (business impact risk analysis) review process in light of climate change adaptation. Build into the review a more detailed range of possible climate change impacts on our activities.	L
We will build greater resilience into our third party supply chain through procurement processes which highlight the need to consider and mitigate climate change issues.	L
Longer term actions:	
We will continue to consider climate change and its spatial variation in our contingency planning, alternative ways of working and the provision of suitable safeguards.	

Measures already implemented (for all Business Continuity and Estates objectives)	Cost
We have assessed the current risk of flooding to CIS systems and servers.	(L)
Operational and project management adaptation plans take increased level of asset deterioration due to climatic changes into account.	(L)
Our current policy is to achieve BREEAM ratings 'excellent' for new buildings we construct and BREEAM 'good' for those buildings we lease. This ensures a degree of	(L)

resilience to climate change impacts by ensuring we use resources efficiently and that buildings are better equipped to deal with climate extremes. However the availability of BREEAM “good” leased properties & land to build BREEAM excellent properties may be low in certain locations & this may affect our ability to be resilient to climate change.	
--	--

Opportunities	
•	Operating costs of buildings may reduce.
•	Opportunity for a greener property portfolio which will be more efficient and better for the reputation of the EA – financial considerations is the key consideration.
•	Opportunity for greening our fleet. This is an ongoing task – we follow government standards and targets for government fleet, and this doesn’t have the same financial implications as greening our buildings.
•	In future it may useful to measure whether the frequency of disruptions to our business is reduced when the effects of climate change become more pronounced, and direct causal links can be identified.
•	Possible greater use of working with partners to maintain activities and meet response levels (shared resources).

Key references:

UK Climate Impacts Programme, 2002 *Climate change scenarios for the United Kingdom*. UKCIP. Available online at:
http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=161&Itemid=291

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Managing the environment in a changing climate

A report to Defra and the Welsh Assembly Government in
response to a direction to report under the provisions of the
Climate Change Act 2008

November 2010

Annex 3 – Strategic risk assessment

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Introduction

This is an annex to our report *Managing the environment in a changing climate*, which sets out our climate risks and adaptation plans in response to a direction under the Climate Change Act 2008 from the Secretary of State for Environment, Food and Rural Affairs and the Welsh Ministers. It should be read together with the main report and the other annexes to understand the approach we have taken, our climate risks and adaptation plans.

This annex explains how we have compared and prioritised our climate risks.

Our risk assessment method (Annex 1) works by:

- identifying organisational objectives;
- screening out those that are not sensitive to climate change;
- collecting evidence to show how sensitive objectives will be affected by climate change;
- evaluating the importance of each risk with four attributes (importance, proximity, resources and inertia).

Annex 2 summarises our evidence for climate risk to each objective. It also presents our judgement on how significant risks are in the four dimensions of:

- Importance
- Proximity
- Resources
- Inertia.

Our strategic risk assessment is technically straightforward. We have already judged how individually significant our risks are – now we need to compare them to understand which are most important and deserve highest priority. We are particularly interested in knowing when delivery of our risks could:

- be unsustainable under climate change and current levels of resources and delivery (that is, those judged to have moderate, severe or substantial importance);
- be unsustainable already or in the short term (that is, those judged to have impacts now or in the short-term on our proximity scale);
- require additional resources to adapt (that is, those judged to need moderate, substantial or major resources);
- be slow to adapt (that is, judged to be long-term on our inertia scale);
- have characteristics that interact synergistically (for example, require urgent attention because they have short-term proximity and long-term inertia).

We also need to consider how risks and adaptation responses will interact so that we can take a holistic approach to environmental change. This is particularly important for the many risks and actions that stem from change to water quality and availability, and the need to address wildlife impacts across different sectors.

It is also helpful to take a step back from the detail of our risk assessment to understand the bigger picture. Our assessment has looked at climate risk to the achievement of 55 organisational objectives. This detail is helpful for our own adaptation planning, but it is worth remembering that these objectives fall across fifteen areas of our business and often indicate more general trends and issues that need to be addressed. This bigger picture helps us understand the general attitude and approach we need to take to climate risk in different areas of our work.

This annex is divided into four sections:

- risk screening, explaining which objectives are considered further in the assessment;
- a description and comparison of how risks score on our four criteria;
- interpretation of our priorities and interdependencies;
- a discussion of uncertainty in our assessment and barriers to adaptation.

Risk screening

We identified 55 organisational objectives for the purposes of this assessment. Annex 1 sets these out and Annex 2 explains whether each is:

- insensitive to climate change;
- sensitive to climate change (where delivery is at risk);
- influenced by climate change (where delivery is not at risk but we might want to change how we work).

Table 1 (overleaf) shows the number of objectives in each of these categories.

Climate sensitive objectives are potentially at risk and are considered further in the assessment. It is worth noting that:

- departments have different numbers of objectives and this reflects the diversity of their work rather than its relative importance;
- the sensitivity of objectives varies between departments and most have either entirely sensitive or entirely influenced objectives, depending on their work;
- only one objective was considered entirely insensitive to climate change (a waste reporting requirement).

The risk screening shows that our departments can be broadly divided into those that are sensitive to climate change and those that are influenced by it. For sensitive departments, climate change presents an operational risk and so adaptation needs to be considered in work planning. For influenced departments, climate change is not an operational risk but may still have a bearing on how work is delivered in the future.

	Number of objectives		
	Sensitive	Influenced	Insensitive
Inland flooding	4		
Coastal flooding and erosion	4		
Water resources	3	1	
Water quality	2		
Regulated business		7	1
Land quality	1	4	
Conservation and ecology	4	1	
Fisheries	7		
Navigation	2		
Recreation	2	1	
Sustainable places		3	
Climate change	1*	1	
Business continuity and estates	5		
Total	35	19	1

Table 1 – Risk screening

* Note: a second climate change objective is sensitive but excluded from further analysis because it relates to the organisation adapting to climate risk (12.2 - We help people and wildlife adapt to climate change and reduce its adverse impacts). In effect, this whole report and assessment sets out the scale of climate risks and adaptation response under that objective.

Comparing our climate risks

This section discusses how sensitive objectives compare by our four criteria. Table 7 at the end of this annex summarises how each sensitive objective has been characterised.

Importance

The importance attribute identifies whether we expect:

- to be able to deliver each objective under climate change, given existing resources and ways of working;
- impacts on each objective to have impacts on the wider organisation.

Importance was rated as either:

- Severe - our objective could be unachievable with current resources and delivery and this could have major impacts on the wider organisation (for example, legal challenge or undermines our licence to operate).
- Substantial - our objective could be unachievable with current resources and delivery and this could have some impact on the wider organisation.
- Moderate - our objective could be unachievable with current resources and delivery but this will have little or no impact on the wider organisation.

- Minor - there will be some impact on our objective with current resources and delivery.
- Negligible - there will be virtually no impact on our objective with current resources and delivery.

Table 2 shows how risks were rated at different levels of importance.

Importance – how could climate change compromise delivery?	Best Case	Worst Case
Severe	0	6
Substantial	16	15
Moderate	7	4
Minor	6	7
Negligible	6	3

Table 2 – Importance of our climate risks

Between 23 and 25 objectives were rated as facing potentially moderate or more serious impacts. These could be unachievable given current ways of working.

Between 16 and 21 of these were rated as facing potentially substantial or severe impacts, meaning that they could have wider repercussions for the organisation (for example, if they could involve legal infractions under European Directives).

Of the six potentially severe risks:

- Four relate to managing the likelihood and consequences of inland and coastal flooding.
- Two relate to managing water to ensure that it is used properly and efficiently whilst ensuring that abstraction does not have an unacceptable impact on the environment or other users.

Of the sixteen potentially substantial risks:

- Four relate to managing inland and coastal flooding to ensure public understanding and environmental benefits.
- Four relate to managing fisheries.
- Three relate to our conservation objectives.
- One is to ensure that there is enough water available for people, business, industry and agriculture most of the time.
- One each relate to water quality, land quality and navigation.

There is considerable overlap between some of these objectives, where different parts of the business have complementary responsibilities:

- Four objectives relate to conservation, land quality, fisheries and water quality objectives under the Water Framework Directive.
- Two objectives relate to equivalent conservation and fisheries duties under the UK Biodiversity Action Plan, the England Biodiversity Strategy and the Wales Environment Strategy.

Although this shows that some risks have been picked up more than once in the assessment, it also provides assurance that they have been rated consistently in the assessment. Stepping back from the detail of individual objectives, the parts of our business facing the most potentially serious substantial or severe impacts are:

- Inland flooding.
- Coastal flooding and erosion.
- Fisheries and Conservation (under WFD and other regimes).
- Water resources and quality (under WFD and other regimes, including land quality contribution to WFD).

These are priority areas for further action.

One navigation risk was also rated as substantial at worst case, or moderate at best. This relates to the potential for bankside collapse following drought where channels are raised above the floodplain. Although such an event could be serious, we need to note that:

- we are not the competent navigation authority in many parts of England and Wales, so this is a localised risk for us;
- this issue is only relevant to waterways with a raised construction (mostly some parts of East Anglia);
- this event could have large clear-up and repair costs but is considered unlikely to happen (that is, a low probability, high consequence risk).

We therefore need to address this risk in our adaptation programme but it is best considered a specific operational risk rather than a widespread organisational one.

Only four risks were rated moderate at worst case, and so considered potentially unachievable but with little or no impact on the wider organisation. Three relate to internal business support functions:

- providing suitable facilities (property, fleet and other assets);
- acquiring land to deliver our objectives;
- minimising and mitigating the effects of a disruption on the business from an unforeseen event and meeting the requirements of the Civil Contingencies Act.

The rationale for rating these as moderate risks only is that our operations are decentralised and with very few critical individual sites or assets. So although there is a theoretical risk to these objectives, and adaptation is needed, any impacts on the organisation are likely to be localised and short-term.

Potential economic impacts on fisheries were also rated as a moderate risk.

Proximity

The proximity attribute identifies when we expect our current way of working to become unsustainable due to climate change. This includes both:

- the viability of objectives;
- the sustainability of current resources and means of achieving objectives.

Note that proximity refers to the sustainability of current ways of working rather than appearance of physical climate impacts. Some of our objectives involve long term plans that may be unsustainable long before climate impacts are felt. For example, a particular flood defence scheme may be unsustainable now due to climate impacts expected at the end of the century. Other objectives have short term planning horizons and may be sustainable until physical climate impacts appear.

Proximity was rated as either:

- Now - current resources and delivery are already potentially unsustainable under climate change.
- Short-term - current resources and delivery could be unsustainable by 2030.
- Medium-term - current resources and delivery could be unsustainable by 2060.
- Long-term - current resources and delivery could be unsustainable by 2100.

Table 3 shows how the proximity of risks was rated.

Proximity – when could current resources and delivery become unsustainable under climate change?	Best Case	Worst Case
Now	5	9
Short-term (by 2030)	11	18
Medium-term (by 2060)	16	6
Long-term (by 2100)	1	0

Notes: Worst case means impact felt sooner; proximity not rated for two negligible risks.

Table 3 – Proximity of our climate risks

Nine objectives were considered to have already unsustainable delivery at worst case. Two of these relate to managing the probability of coastal and inland flooding and are well supported by evidence. We have high confidence in these ratings and they were also rated now at best case. The other seven relate to ecological impacts under either conservation, fisheries or coastal risk management objectives.

These potentially unsustainable objectives represent inland flooding, coastal flooding and erosion, and fisheries and conservation, which also have impacts rated as

potentially severe or substantial. This confirms that they need to be priorities in our adaptation programme.

Objectives under water resources and quality were also rated as having potentially substantial or severe importance. These were rated as having either short or medium term proximity.

Only one risk has a potentially long-term proximity, which related to water quality impacts from diffuse pollution (Objective 6.4). There was low confidence in this rating, and it was also considered to have medium-term proximity at best case.

Inertia

The inertia attribute measures how quickly we can respond to climate change, including both:

- the lead-in time to our first response;
- flexibility for subsequent changes in response.

Note that this is an ‘in principle’ rating, and assumes that resources are available and that legislative changes can be made, where they are needed.

Inertia was rated as either:

- Rapid - within 2 years
- Short-term - within one corporate planning cycle (5 years)
- Medium-term - within two corporate planning cycles (10 years)
- Long-term - longer than two corporate planning cycles (10+ years).

Table 4 shows how the inertia of risks was rated.

Inertia – How quickly can we adapt?	Best Case	Worst Case
Long-term (more than 10 years)	1	5
Medium-term (within 10 years)	1	5
Short-term (within 5 years)	19	18
Rapid (within 2 years)	12	5

Notes: Inertia not rated for two negligible risks

Table 4 – Inertia of our climate risks

Table 4 shows that we can, in principle, adapt the majority of our objectives in the short term, within 5 years.

Four of the five objectives rated as having medium term inertia relate to water resources and water quality. These were also rated as having short or medium term

proximity. This means that they could become unsustainable by as soon as 2030 and take up to ten years to adapt in principle (or longer if there are other constraints).

The combination of proximity and inertia ratings therefore suggests that adaptation action for water resources and water quality is urgent, making these priorities for our adaptation programme.

The other objective rated with medium inertia relates to managing our own land to support culture and recreation and was only rated as a minor risk, meaning that it was still achievable using current resources and delivery.

Of the five objectives with potentially long term inertia, three relating to business continuity were rated rapid at best case. The upper end of this range reflects that some of our sites and buildings are leased on long-term contracts, reducing opportunity to adapt. However, the importance of impacts on these objectives was rated moderate, meaning that little or no impact is expected on the wider business.

Our objective to manage the impact of diffuse pollution on water quality (Objective 6.4) was also rated with an inertia of long term at worst case and medium term at best. Impacts on this objective were rated as potentially substantial and so this is a priority for our adaptation programme.

The remaining objective with long term inertia relates to reducing our own carbon emissions and was rated as a negligible risk.

Resource

The resource attribute measures the resources we need to adapt.

Resource needs were rated as either:

- Minor - we can reallocate resources from within the same department.
- Moderate - we will need to reallocate resources between departments.
- Substantial - we cannot fully adapt without some additional external resources.
- Major - we cannot fully adapt without significant additional external resources.

Note that this is a relative rather than absolute scale so 'significant additional external resources' for one objective may not be the same amount of money as for another.

Table 5 shows resource ratings for our risks.

Resource – What effort is needed to adapt?	Best Case	Worst Case
Major	7	8
Substantial	7	8
Moderate	8	8
Minor	11	9

Notes: Resource not rated for two negligible risks

Table 5 – Resource requirements for our climate risks

Sixteen objectives were rated as having major or substantial resource needs at worst case, suggesting that additional external resources might be needed. Of these:

- four relate to inland flooding;
- four relate to coastal flooding and erosion;
- two relate to water resources;
- five relate to conservation, ecology and fisheries;
- one relates to navigation.

Inland flooding, coastal flooding and erosion, water resources and wildlife risks were also rated as having severe or major importance, potentially affecting the wider organisation. These are priority risks for our adaptation programme.

The potential cost of the navigation risk is driven by one-off costs in the event of embankment failure, which could potentially be millions of pounds. It is considered that the probability of embankment collapse is low and is relevant only to specific waterways. Although navigation is generally not an adaptation priority, this specific operational risk needs to be addressed further in our adaptation programme if only to better understand the likelihood of its occurrence.

Our priority risks

Of the 55 objectives used in this assessment:

- 35 sensitive are sensitive to climate change and at some risk from it;
- 25 were rated as potentially unsustainable at worst case with current resources and delivery (that is, rated severe, substantial or moderate importance, 23 at best case);
- 21 were rated as having impacts that could affect the wider organisation at worst case (that is, rated severe or substantial importance, 16 at best case);
- 20 objectives were considered not to be at risk (19 were considered to be climate influenced and one considered completely insensitive).

Our most important risks are grouped across four areas of our business, making these priorities for our adaptation programme (Table 6).

Our priority risks	Rationale
Inland flooding	These risks are likely to increase with climate change. We are already factoring climate change into our flood risk management approaches. Funding levels will need to increase in the future to maintain current levels of protection.
Coastal flooding and erosion	
Wildlife and habitats	
Water resources and quality	Climate change poses significant risks to water resources and quality. While we are already addressing them, our current approach might not be sufficient in the future.

Table 6 – Our adaptation priorities

These are our adaptation priorities but we also need to address climate risks in:

- Navigation – specifically to better understand the small possibility of bankside collapse in waters that we manage.
- Business continuity and estates – particularly to better understand our risks in order to review and adapt our incident management strategy, even though we do not expect them to affect the wider organisation.

Annex 2 sets out adaptation plans for all our objectives that are sensitive to climate change. It also sets out plans to change the way we deliver climate influenced objectives to make sure that we work effectively and take advantage of any opportunities afforded by climate change.

Interdependencies

There are many interactions between our objectives, climate risks and adaptation plans.

Figure 1 shows how areas of our business interact at a high level.

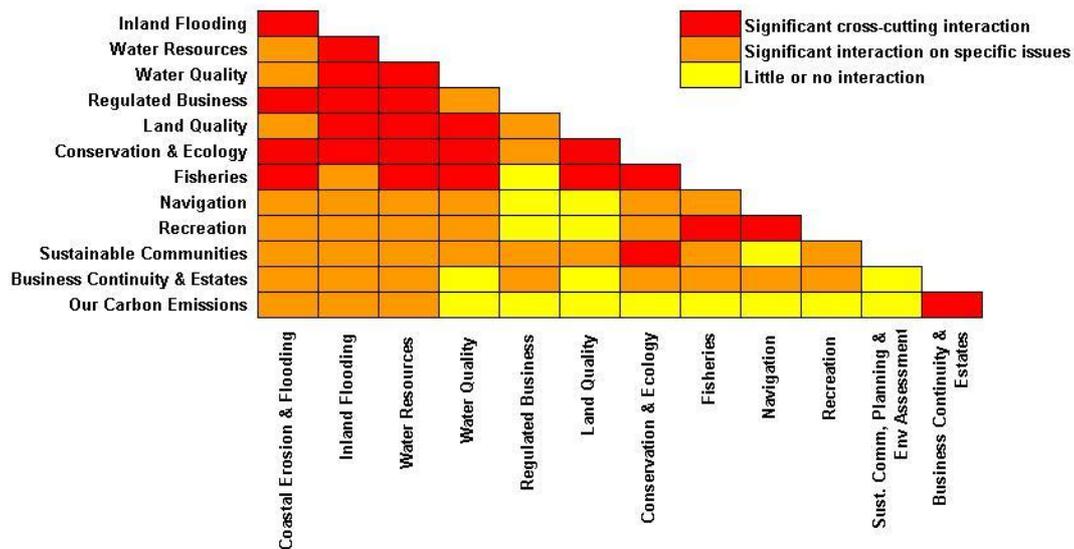


Figure 1 – Interaction between our climate risks

Figure 1 shows that there is significant interaction between our priority risks (inland flooding, coastal flooding and erosion, water resources and quality, conservation and fisheries). However, interaction between these areas of our business is broader than simply climate risks. We take a holistic approach to the environment and routinely coordinate our work across these areas to ensure we are working effectively and consistently between them.

We will extend this holistic approach to our adaptation programme to ensure that adaptation is joined up across our organisation and is embedded in the way we work.

We work with many others to manage the environment effectively, including:

- local and sub-national authorities;
- government agencies (for example The Forestry Commission, Natural England);
- the water industry;
- other industry;
- academic and third sector organisations.

We will continue to work with current partners and develop new relationships to ensure we are adapting effectively. Annex 2 identifies the key interdependencies for each risk.

Barriers and uncertainty

Barriers

There are a range a barriers which have the potential to challenge our ability to adapt effectively to climate change. These include:

- Evidence – uncertainty will always be a potential barrier to effective adaptation, and we need to develop good evidence to reduce that uncertainty. However, we can still develop robust adaptation options now. Our plans aim to improve our evidence base, and include flexible actions based on the existing evidence while ensuring no or low regrets if that evidence changes;
- Partners – we are dependent on our partners and stakeholders, and will work closely with them to avoid barriers to effective adaptation;
- Regulation – we will work with Government to ensure that regulations are appropriate;
- Funding – our ability to adapt depends partly on the funding we have available and we have indicated where additional resource will be needed;
- Timescales – some of our adaptation actions will take time to implement and in some cases, further time to take effect. This report identifies where we need to act now and what we are doing to adapt effectively (see Annex 2).

Uncertainty

Some of the uncertainty in this assessment stems from climate projections or incomplete understanding of environmental processes. However, uncertainty also arises from interaction with other stakeholders or regulatory processes.

We have made a qualitative assessment of uncertainty in this assessment by characterising confidence in ratings of impact and response.

Confidence in ratings of importance and proximity was expressed as:

- very low – based on expert judgement or weak evidence only;
- low – based on few, incomplete, inconclusive impact studies;
- medium – based on expert interpretation of a number of (potentially conflicting) impact studies;
- high – based on impact studies that give a consistent picture but do not explore uncertainty fully;
- very high – based on many impact studies that give a coherent picture and explore uncertainty fully.

Confidence in ratings of resource and inertia was expressed as:

- very low – we do not have sufficient understanding of the impact to be able to suggest any possible response;
- low – we do not have a good understanding of our response;
- medium – we understand the nature and scale of the response required (for example, change of policy, major legislative intervention etc);
- high – we have scoped the feasibility of specific responses;
- very high – we have scoped the feasibility of specific responses and have developed policy for best practice.

Figure 2 plots confidence in ratings of impact against confidence in ratings of response for each climate sensitive area of our business (that is, importance and proximity against resource and inertia, respectively).

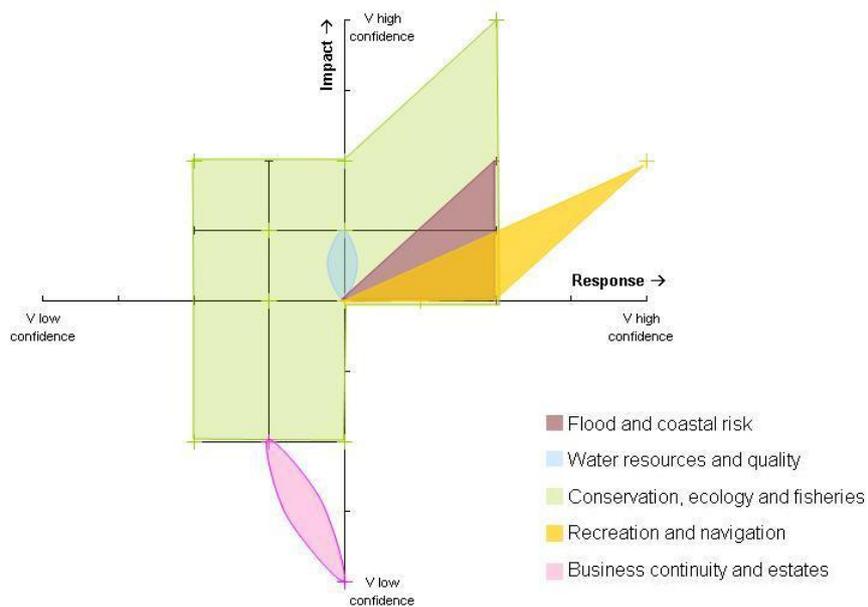


Figure 2 – Confidence in ratings of impacts and response

Figure 2 shows that risks are characterised by uncertainty over impacts, or response, or both. Or to put it another way, barriers to adaptation result from uncertainty in impacts and response.

Our adaptation approach for each risk depends on the nature of uncertainty. For example, we have reasonable confidence in both impacts and response for inland flooding and coastal risk, allowing us to plan long-term investment programmes to manage defences. On the other hand, our business continuity risks are characterised by low certainty over impacts but moderate certainty over responses. This means we may need some better evidence but on the whole are able to plan adaptation strategies reasonably confidently.

Annex 2 sets out our adaptation plans. Many of these identify specific research needs to improve our understanding of climate risks, or identify actions to improve confidence in the delivery of adaptation actions.

Table 7 – Characterisation of risks to sensitive objectives (see Annex 1 for full details of objectives)

Notes: Best case and worst case refers to both variability and uncertainty – see Annex 1 Methodology

Objective	Risk						Adaptation					
	Importance		Proximity		Confidence		Resource		Inertia		Confidence	
	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst
1.1 - Understanding of inland flooding	Substantial	Substantial	Short	Short	High	High	Substantial	Substantial	Short	Short	High	High
1.2 - Reduce the probability of inland flooding	Substantial	Severe	Now	Now	High	High	Major	Major	Short	Short	High	High
1.3 - We will reduce the consequences of inland flooding	Substantial	Severe	Short	Short	High	High	Major	Major	Short	Short	High	High
1.4 - Our inland flood programme provides environmental benefits	Substantial	Substantial	Short	Short	Medium	Medium	Major	Major	Short	Short	Medium	Medium
2.1 - Understanding of coastal flood	Substantial	Substantial	Short	Short	Medium	Medium	Substantial	Substantial	Short	Short	High	High
2.2 - Reduce the probability of coastal flooding	Substantial	Severe	Now	Now	High	High	Major	Major	Short	Short	High	High
2.3 - We reduce consequences of coastal flooding	Substantial	Severe	Short	Short	Medium	Medium	Major	Major	Short	Short	High	High
2.4 - Our coastal flood programme provides environmental benefits	Substantial	Substantial	Now	Now	Medium	Medium	Major	Major	Short	Short	Medium	Medium
3.1 - Water abstraction has no unacceptable impact	Substantial	Severe	Short	Short	Medium	Medium	Substantial	Substantial	Short	Medium	Medium	Medium

Table 7 – Characterisation of risks to sensitive objectives (see Annex 1 for full details of objectives)

Notes: Best case and worst case refers to both variability and uncertainty – see Annex 1 Methodology

Objective	Risk						Adaptation					
	Importance		Proximity		Confidence		Resource		Inertia		Confidence	
	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst
3.2 - Ensure there is enough good quality of water for users	Substantial	Substantial	Medium	Short	Medium	Medium	Substantial	Substantial	Short	Medium	Medium	Medium
3.4 - Ensure water is used properly and efficiently	Substantial	Severe	Medium	Short	High	Medium	Moderate	Moderate	Short	Medium	Medium	Medium
4.1 - Monitor STW, trade discharges and water quality	Minor	Minor	Medium	Short	Medium	Medium	Minor	Minor	Short	Medium	Medium	Medium
4.2 - WFD (water quality)	Substantial	Substantial	Medium	Medium	Medium	Medium	Moderate	Moderate	Short	Short	Medium	Medium
6.4 - WFD (land quality)	Substantial	Substantial	Long	Medium	Low	Low	Minor	moderate	Medium	Long	Medium	Medium
7.1 - Contribute to Eng/Wales biodiversity strategy (Conservation)	Moderate	substantial	Now	Now	High	High	Major	Major	Rapid	Rapid	Medium	Medium
7.2 - Conserve SSSIs and manage our own	Moderate	substantial	short	Now	High	Medium	Moderate	substantial	Rapid	Short	High	Low
7.4 - Environmental Liability Directive (Conservation)	Negligible	Negligible	-	-	V High	V High	-	-	-	-	High	High
7.5 - WFD (Conservation)	Substantial	Substantial	Medium	Now	Medium	Medium	Minor	Minor	Short	Short	High	Medium
8.1 - Maintain fish diversity and habitat	Substantial	Substantial	Short	Now	High	Medium	Substantial	Substantial	Rapid	Short	Medium	Low
8.2 - Fisheries economy	Minor	Moderate	Short	Short	Low	Low	Minor	Minor	Short	Short	Low	Low

Table 7 – Characterisation of risks to sensitive objectives (see Annex 1 for full details of objectives)

Notes: Best case and worst case refers to both variability and uncertainty – see Annex 1 Methodology

Objective	Risk						Adaptation					
	Importance		Proximity		Confidence		Resource		Inertia		Confidence	
	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst
8.3 - Angling	Minor	Minor	medium	Short	Low	Low	Minor	Minor	Short	Short	Medium	Medium
8.4 - Delivery of the Wales Fisheries Strategy	Minor	substantial	Medium	Now	High	Low	Minor	Substantial	Rapid	Short	Medium	Low
8.5 - WFD (Fish)	Substantial	Substantial	Short	Short	Medium	Medium	Moderate	Moderate	Short	Short	Medium	Medium
8.6 - Contribute to Eng/Wales biodiversity strategy (Fish)	Moderate	Substantial	Now	Now	High	High	Substantial	Major	Short	Short	Low	Low
8.7 - Environmental Liability Directive (Fisheries)	Negligible	Negligible	-	-	V High	V High	-	-	-	-	High	High
9.1 - Maintain navigation and assets	Moderate	Substantial	Medium	Short	Medium	Medium	Substantial	Substantial	Short	Short	Medium	Medium
9.2 - Promote urban and rural regeneration through navigation	Negligible	Minor	Medium	Short	Medium	Medium	Minor	Minor	Rapid	Rapid	Medium	Medium
10.1 - Promote recreation in our waterways	Minor	Minor	Medium	Short	High	High	Moderate	Moderate	Rapid	Rapid	V High	V High
10.2 - Manage our own land for culture and recreation	Minor	Minor	Medium	Medium	Medium	Medium	Minor	Minor	Rapid	Medium	High	Medium
12.3 - Reduce our carbon emissions	Negligible	Negligible	Short	Short	Medium	Medium	Minor	Minor	Long	Long	Medium	Medium
13.1 - Our facilities	Moderate	Moderate	Medium	Medium	Low	Low	Moderate	Moderate	Rapid	Long	Medium	Low

Table 7 – Characterisation of risks to sensitive objectives (see Annex 1 for full details of objectives)

Notes: Best case and worst case refers to both variability and uncertainty – see Annex 1 Methodology

Objective	Risk						Adaptation					
	Importance		Proximity		Confidence		Resource		Inertia		Confidence	
	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst	Best	Worst
13.2 - Efficiency in our working practices and assets	Negligible	Minor	Medium	Short	V Low	V Low	Minor	Minor	Rapid	Rapid	Medium	Medium
13.3 - Acquire land for our objectives	Moderate	Moderate	Medium	Medium	Low	Low	Moderate	Moderate	Rapid	Long	Medium	Low
13.4 – Business continuity and civil contingency	Moderate	Moderate	Medium	Medium	Low	Low	Moderate	Moderate	Rapid	Long	Medium	Low
13.5 – Our people, systems and property work effectively	Negligible	Minor	Medium	Short	V Low	V Low	Minor	Minor	Rapid	Rapid	Medium	Medium

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